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Attending to global environmental concerns calls for renewed efforts in environmental education and environmental literacy. Important questions regarding equity and access also need to be considered (NAAEE, 2011). Therefore, a goal of this study was to develop a framework for Critical Environmental Agency (CEA) that builds on the work of science education equity scholars (Calabrese Barton & Tan, 2008; Tan, Calabrese Barton, Turner, & Gutiérrez, 2012) while incorporating specific components of environmental education (Greenwood, 2012; NAAEE, 2011). An additional goal of this study was to expand and broaden the understanding of how diverse youth engage in environmental education come to see themselves as people who care about the environment and are resolved to help create a more just world. Finally, this study used CEA as a way to qualitatively assess youths' environmental literacy development.

Using a critically-oriented sociocultural perspective, I conducted a largely qualitative ethnographic study, which explored the CEA development of 16 diverse youth from low income families who had not attended college. The youth participated in a field ecology program focused on herpetology (the study of reptiles and amphibians) that was a part of a larger multi-year college access program. Data collected included: individual interviews, photovoice focus groups, photovoice assignments, pre/post-tests, pre/post surveys and observations and field notes. Data analyses focused on how youths'

experiences were leveraged to develop CEA, how youths' CEA was enabled, and how youths' CEA was constrained.

The findings of this study inform our understanding of how diverse youth engage in environmental education and strengthen their CEA. Youths' CEA was most often enabled when they had opportunities to explore their local communities, were given the freedom to make decisions during community explorations, and were provided with multiple opportunities to engage in the practices of field ecology, as success did not always come on their first attempt. The findings also inform our understanding of obstacles that hinder youths' CEA development. Obstacles in this study included youths' limited understanding of local environmental issues, their own views of themselves as not "outdoors" or "science" people, and their thoughts that urban environments were divorced from nature. Implications from this study suggest that youth should be afforded opportunities to act upon, even if in small ways, what they come to see as important for their community's environmental well-being.

CRITICAL ENVIRONMENTAL AGENCY IN A FIELD ECOLOGY PROGRAM

by

Lacey Denise Huffling

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the Faculty of the Graduate School at
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Approved by

Committee Chair

To my very first teachers, my parents, and my husband, Brian, for your love, support, encouragement, prayers, faith, and teaching through the years. To the memory of Mr. Orpheus E. Deaver, Jr., my tenth grade Biology teacher, and the first to insist that I was a "science person." Through his persistence, I came to see myself as one. May I do the same for my students.

APPROVAL PAGE

This dissertation written by LACEY DENISE HUFFLING has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

The purpose of this dissertation was to explore environmental education (EE) through an identity and equity lens by observing and interacting with diverse students in a field ecology research experience focused on herpetology (the study of amphibians and reptiles), which was part of a college-access program (Academy HRE). This study is important because field ecology experiences might provide entry points into the science pipeline for students who have been historically marginalized in the sciences, as the practices of field sciences are very different from those of laboratory sciences (Bowen & Roth, 2007; Korfiatis & Tunnicliffe, 2012) and because children are spending less and less time in nature (Louv, 2008).

To this end, I developed Critical Environmental Agency (CEA), which builds on Critical Science Agency (CSA), a framework used in science education. I also incorporated specific components of environmental literacy and environmental education (EE) in the CEA model. CEA utilizes the three principles of CSA, which imply participants:

> (a) gain a deep understanding of science and the processes, skills and modes of inquiry associated with the content of science; (b) identify themselves as experts in one or more realms associated with the content of science; (c) and use science as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just. (Calabrese Barton & Tan, 2008, p. 6)

I added two additional EE principles from place and environmental literacy research, which imply participants:

> (a) gain a deep understanding of place, leading to a critical consciousness of place (Greenwood, 2012); and (b) strengthen their sense of place and demonstrate behaviors, actions, and/or individual and/or collective agency to consider, discuss and/or act on environmental issues (NAAEE, 2011).

After I generated the concept of CEA, I used this framework to explore diverse students' participation in the Academy HRE. Additionally, I examined how CEA was enabled and/or constrained for participants in the Academy HRE.

The Academy HRE ran for one month during the summer, and participants met for two hours, four days a week. The course covered the basic natural history of amphibians and reptiles, with specific emphasis on local herpetofauna and environmental issues they faced. During the program, one day a week was spent on a field or laboratory investigation (such as a salamander population investigation at a local ephemeral pool or in class snake dissections). More detailed explanations of the Academy HRE course content are provided in Chapter 3.

The Academy HRE curriculum also contained a photovoice project (using documentary photography for social action (Wang & Burris, 1997)). Chapter 3 provides relevant literature on photovoice methodology and specific details about the Academy HRE project, including how it was implemented. Through the photovoice project, youth had opportunities to display and develop their community and herpetology expertise, with the goal of speaking for themselves as well as on behalf of local amphibians and reptiles.

My research was part of a larger initiative, *Herpetological Education in Rural Places and Spaces* (the HERP Project), which was sponsored by the National Science Foundation. The HERP Project ran three herpetological research experiences (HRE), two of which were week-long summer residential programs with five or six follow-up days/multiple day events offered during the school year. At four weeks, the Academy HRE was the longest summer program, although the total number of hours spent in each HRE was comparable since the week-long HREs offered as much as three to four hours of instruction each morning and evening. I had leadership roles in both week-long HREs from 2012 to 2014. I was the assistant director for the first HRE, and I was the lizard project leader for the second HRE, teaching participant groups about lizards and running a field investigation to examine the local lizard population. In 2013, while I was collecting data for my dissertation study, I also served as a teaching assistant for the Academy HRE. I helped to co-plan the photovoice project. I taught a session on lizards and a session on photovoice. I provided technological expertise, helped run field investigations, and assisted students in the classroom when they had content questions or were working with live animals. My intimate involvement with the Academy HRE greatly informed my research, and in chapter 3, I address how I handled possible validity threats.

Importance of the Study

Most of the detrimental changes to ecosystems around the world are due to anthropogenic activities, which in turn are causing rapid decreases in global biodiversity thus negatively impacting environmental health (Vitousek, Mooney, Lubchenco, &

Melillo, 1997). The accelerated rate of species loss is one of the most urgent environmental issues in the 21st century (Groom, Meffe, & Carroll, 2006; Heywood, 1995). To combat global biodiversity decline, several international organizations (United Nations Educational, Scientific & Programme, 1993; World Resources Institute, The World Conservation Union, & United Nations Environment Program, 1992) have issued statements indicating the need to raise public awareness regarding the preservation of biological diversity in order to safeguard species richness across the planet. With the predicted increases in global population, environmental degradation, and global species loss, there is a pressing need for environmental education (EE).

EE evolved from educational movements of the late 19th and early 20th centuries, which focused on nature study, conservation/preservation, and outdoor learning. Today, EE is considered a multidisciplinary endeavor, with scientists, economists, and political scientists each holding a stake as human impacts on Earth's natural systems have never been greater. The interdisciplinary nature of EE is demonstrated by one of the earliest definitions:

> Environmental education is a process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulating of a code of behavior about issues concerning environmental quality. (G. C. Martin, 1975, p. 21)

As indicated by this definition, EE involves not only scientific understanding but also encourages one to make decisions for the good of society and nature. The ultimate goal of

EE is to educate environmentally literate citizens; people who can make informed environmental decisions and are willing to act on their decisions.

In 2011, the North American Association of Environmental Education (NAAEE) developed a comprehensive framework for assessing environmental literacy. In developing this framework, NAAEE scholars identified four components of environmental literacy: knowledge, dispositions, competencies, and environmentally responsible behavior. The framework proposed to assess environmental literacy is for the 2015 Programme for International Student Assessment (PISA) (NAAEE, 2011).

In the US, the 2009 No Child Left Inside Act (NCLI) was proposed to Congress as a way to support and enhance EE in elementary, middle, and high schools. This piece of legislation did not define environmental literacy; rather each individual state was tasked with developing its own definition. In 2013, a congressional committee reintroduced NCLI as an amendment to the Elementary and Secondary Education Act of 1965 and in 2014 was under review. In response to NCLI, many states (and the District of Columbia) are in the process of developing an Environmental Literacy Plan (ELP). NAAEE (2013) staff surveyed individuals from 47 states, as well as the District of Columbia, and found that 14 states had completed and adopted an ELP; 11 states had completed a plan and were awaiting adoption of the ELP; and 23 states were in the planning and writing stages of preparing their ELP. In 2010, the state of Maryland became the first state to add environmental literacy standards as a requirement for high school graduation. Beginning in the 2011-2012 school year, all students were required to participate in a locally-designed program of environmental literacy. The class of 2015 will be the first group of students to graduate who have completed a locally-designed high school program of environmental literacy. In the state where my study takes place, the final draft of the ELP was submitted for governmental approval in July 2014.

With the increased emphasis on environmental literacy and the development of assessments, EE seems to be following the lead of current U.S. educational policy for science education. The current focus on whether or not students' scientific literacy is improving is two-fold: Student test scores are used as indicators of science achievement and STEM career statistics are used as indicators of interest in science (Deboer, 2000; Langdon, McKittrick, Khan, & Doms, 2011). This dual focus on test scores and statistics has led to a national conversation concerning the science achievement gap and STEM participation gap between diverse students and their Caucasian counterparts. Though this has illuminated the fact that inequities exist in science education, the emphasis on quantitative data has limited the types of questions that can be explored. For instance, the following questions cannot be addressed by simply analyzing quantitative data: What types of inequities exist? How are these inequities perpetrated? Are these inequities resilient and if so, why? How do policy makers, administrators, and education professors encourage more equitable practices? These questions led to even more questions regarding the nature of equitable science education: What is equitable science education? How and in what ways does equitable science instruction increase diverse students' science literacy? What type of scientific literacy emerges in equitable classrooms?

Several scholars have researched science-learning environments, emphasizing diverse students and their affiliations with science (Brickhouse & Potter, 2001;

Brickhouse, Lowery, & Schultz, 2000; Calabrese Barton & Tan, 2010; Carlone, Haun-Frank, & Webb, 2011; Carlone, 2004; Tan & Calabrese Barton, 2007; Tsurusaki, Calabrese Barton, Tan, Koch, & Contento, 2013). These equity scholars have examined both in school and out of school settings, elementary school classrooms to college classrooms, and specific science disciplines such as physics, biology, and chemistry. However, environmental literacy is one area that has not been fully explored (Ardoin, Clark, & Kelsey, 2013) even though inequities, such as access, exist within EE (Taylor, 2002).

To better understand issues of accessibility and equity in science education, equity scholars have utilized identity as a sociocultural construct through which to examine how science-learning experiences enable or constrain students' abilities to view themselves and be recognized by others as someone who is successful and able to contribute to science. Identity research in EE has mostly focused on how an individual relates to the natural environment (Clayton, 2003) and has not addressed how one is positioned by others and what affordances or constraints this positioning can have on one's identity. Thus, EE could benefit from identity research steeped in critically-oriented sociocultural theory. In addition, environmental identity research has almost exclusively focused on adults (Blatt, 2013, 2014; Clayton, 2003; Stets & Biga, 2003), so research focused on youths' environmental identities is needed to advance the field.

Given the current level of environmental concerns that the world faces (Grimm et al., 2008), using an identity and equity lens, such as CSA, could greatly benefit EE. CSA enables scholars to examine the affordances offered to students when their lived experiences are utilized in the curriculum. Students' lives are viewed as belonging in science, and their lived experiences help to broaden the discipline and its practices by contributing to the construction of what counts as science and who is positioned as a "science person."

Rationale for the Study

Youths' lives are affected by science on a daily basis. Whether it is obtaining the weather report to determine how to dress or deciding whether or not to purchase organic milk, youth use scientific information to make decisions even if they are not cognizant of the fact that they are using science. Therefore, it follows that youths' lives are engrained in science. Yet, most science instruction does not readily draw upon youths' lived experiences in science (Tsurusaki et al., 2013). It is unfortunate that youth are not encouraged to bring their experiences into the science classroom because studies have shown that youth are more engaged when science is shown to be relevant to their lives (Barnett et al., 2006; Calabrese Barton & Tan, 2010; Wheaton & Ash, 2008). Thus, youths' lives belong in science and their experiences should be utilized in the classroom.

Since EE draws upon the environmental sciences, students' lives are directly impacted by EE content. Therefore, EE not only has the potential to directly draw upon youths' lives but youths' lives belong in EE as issues of water, air, and land pollution affect everyone. In this regard, youths' lived experiences can also broaden EE curriculum by exposing issues and concerns teachers had not considered; thus, it is a useful and important field to study.

CSA affords an analytical lens through which to explore how youths' lived experiences can be leveraged in service of robust and meaningful science learning. CSA has been used, albeit sparsely, to explore how diverse students participate in science (Basu, Calabrese Barton, Clairmont, & Locke, 2009; Calabrese Barton & Tan, 2010; McNeill & Vaughn, 2012; Tan & Calabrese Barton, 2008; Tsurusaki et al., 2013). When youths' CSA is supported, youth are afforded the ability to develop a deep understanding of science and take action at the individual and community levels.

EE place scholars do leverage students' lived experiences and advocate using the local community as a classroom. EE scholars have found that by engaging students in ongoing field ecology projects students were able to gain a more robust understanding of ecosystems (Barnett et al., 2006; Endreny, 2010). With a more robust understanding of ecological principles, students also showed an increase in concern for local environmental issues (Endreny, 2010). Place-based programs also helped address inequities in science by increasing participation and self-efficacy for minorities and females (Barnett et al., 2006; Barnett, Vaughn, & Strauss, 2011; Fadigan & Hammrich, 2004). Finally, students' connectedness to nature has also been shown to increase when a place-based curriculum is used (Sukhontapatipak & Srikosamatara, 2012).

Thus, place-based pedagogy, sense of place, and CSA should be considered for use in EE, and local ecosystems should be seen as areas to not only engage students in authentic science projects but also to develop deep and meaningful connections to the environment, which will in turn foster more environmental concern and awareness. By using CSA, place-based pedagogy, and sense of place to explore EE programs, information can be gathered on how youths' exhibit CEA: (a) gain in-depth knowledge of EE, (b) recognize themselves as experts in at least one area of EE, (c) develop critical consciousness of place, (d) deepen sense of place and discuss environmental issues, and (e) use EE as a foundation for change.

The Gap in the Literature

According to the *Excellence in Environmental Education - Guidelines for Learning (K-12)* report (NAAEE, 2010), EE should prepare environmentally literate citizens, who live compatibly with nature, act equitably towards others, consider future generations in environmental decision making, and participate actively in society. The current EE research literature is extensive in describing, evaluating, reviewing, and suggesting ways to promote EE in formal and non-formal settings (Bogner, 1998; Chawla, 1998; Dettmann-Easler & Pease, 1999; Hart & Nolan, 1999; Rickinson, 2001; Stevenson, Brody, Dillon, & Wals, 2012). Yet, the focus on how youth view themselves and how others view them in relation to EE is an area that has not been fully explored.

This dissertation study fills an important gap in the EE literature. It provides research regarding diverse youths' participation in an EE program that focused on improving participants' scientific and environmental literacies. By examining this setting, the conversations regarding how diverse audiences participate in EE and how to further encourage their participation can be expanded. It also illuminates how diverse youth see themselves and how others position them in relation to nature. Finally, CEA provides a theoretical framework, which can be used by researchers to qualitatively explore environmental literacy development.

This work provides thick, rich descriptions of diverse youths' environmental literacy development. As environmental literacy becomes more of an international effort, important questions regarding equity and access need to be considered. There is a need for youth to engage with real world, local environmental issues, while having the opportunity to use critical thinking and creativity in development of solutions (NAAEE, 2010). Learning environments that encourage CEA utilize youths' lived experiences and leverage these experiences in service of robust and meaningful EE.

Research Questions

As I explored the ways CEA were enacted and taken up by youth in a month-long summer field ecology research experience focused on herpetology, I addressed the following three research questions:

1) How were youths' experiences leveraged to develop their CEA during the field ecology program?
2) How was CEA enabled during the field ecology program?
3) How was CEA constrained during the field ecology program?

Research Design

Ethnographic traditions guided my study and required me to immerse myself in the research setting, which allowed me to develop thick, rich descriptions of what participants did and furthered my ability to understand the meanings participants made of the learning experiences (Glesne, 2011; Schram, 2006; Spradley, 1980). Thus, this research was conducted within an interpretive paradigm. Within the interpretive paradigm, knowledge is socially constructed by participants in the researched setting, and as a researcher, I attempted to understand the learning experiences from the viewpoint of the participants (Lichtman, 2010).

I used an ethnographic approach (Spradley, 1980) to study the Academy HRE, which was part of a college access program at a university located in the southeastern US. The Academy serves high school students, who come from underrepresented higher education student populations and are potential first generation college students. The academy's mission is to support these students in their development of academic and leadership skills with an emphasis on community and social awareness.

Sixteen of nineteen students in the Academy HRE agreed to participate in my study. There were nine females and seven males; ethnic demographics included 38% African American, 18% Biracial, 38% Caucasian, and 6% Hispanic. Grade levels included five sophomores, eight juniors, and three seniors. Participants are discussed in more detail in Chapter 3.

Data were collected through mostly qualitative measures, though pre/post-tests and surveys were also administered. Observations and field notes (Creswell, 2013), individual interviews, photovoice focus groups, and photovoice assignments comprised the qualitative data. Pre/post-surveys and pre/post-tests comprised the quantitative data sources. All interviews, focus groups, and observations were transcribed, providing text for data analysis. Qualitative data were analyzed using Dedoose, and Statistical Package for the Social Sciences 22 (SPSS) was used for quantitative data analysis. As recommended by Miles and Huberman (2014) and Maxwell (2013), data collection and preliminary data analysis were simultaneous, which aided the collection of more robust and informed data. Thus, data analysis was an iterative process as I combed data for emergent patterns and themes related to the meanings participants made of the experience (Tracy, 2013).

Limitations of the Study

The scope of this study was limited to one environmental program focused on herpetology. The participants chose to be a part of the college access program (admission was by application and interview), and the Academy HRE was selected as an elective course. Student self selected in the sense that they chose to apply for the college access program, and they then selected the herpetology class as one of their elective courses. The duration of the program was short when compared to typical K-12 classroom instruction. Yet, the insights gained from this study are informative in regards to diverse youths' participation in EE programs.

Terms Defined

The terms used in this study are explored in more detail in Chapter 2, which presents an in-depth review of the current literature. The following bolded terms are operationally defined as they are used in this study.

Agency is defined as how individuals' present themselves as "agents whose actions count in, and account for, the world" (Holland, Lachicotte, Skinner, & Cain, 1998, p. 285). Therefore, an individual's agency is determined by her capacity to act in a given situation. Agency is exhibited if the actions occur but the capacity to act can be present whether or not the actions are actually exhibited.

Critical Environmental Agency (CEA) is a framework that I developed as a part of my graduate studies. CEA is based on critical science agency (CSA) (definition below) and principles of EE and explores how youth express themselves in regards to EE. It implies students are able to: (a) gain a deep understanding of the sciences that informs environmental education and the processes, skills and modes of inquiry associated with the sciences; (b) identify themselves as experts in one or more realms associated with environmental education (such as environmental sciences, economics, and political sciences); (c) gain a deep understanding of place, leading to a critical consciousness of place (Greenwood, 2012); and (d) strengthen their sense of place and demonstrate behaviors, actions, and/or individual and/or collective agency to consider, discuss and/or act on environmental issues (NAAEE, 2011); (e) and use EE as a foundation for change, such that their identity (defined below) develops, their position in the world advances, and/or they alter the world towards what they envision as more just.

Critical Science Agency (CSA) is a framework that explores how students express themselves in science. The three principles of CSA imply students are able to: (a) gain a deep understanding of science and the processes, skills and modes of inquiry associated with the content of science; (b) identify themselves as experts in one or more realms associated with the content of science; (c) and use science as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just (Calabrese Barton & Tan, 2008).

Critical Consciousness of Place is learning to recognize environmental destruction and disruption (decolonization) and then apply this newfound awareness to learn to live socially and ecologically responsibly in these places (reinhabitation) (Greenwood, 2012).

Environmental education (EE) is education that instructs individuals to explore environmental problems and issues, engage in problem solving, develop skills to make informed decisions, and take action to improve and protect the environment (NAAEE, 2011).

Environmental literacy is the ultimate goal of EE. According to NAAEE (2011), an environmentally literate person makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of others and the environment; and participates in civic life.

Field ecology is the study of the distribution and abundance of organisms and their interactions with the environment using observational and experimental data in natural settings to understand patterns of distribution and environmental interactions.

Identity is how one sees herself and how others recognize and position her at a given time and place (Gee, 2000).

Herpetology is the study of amphibians and reptiles and in this context focused on their ecological niches, behaviors, adaptations, reproductive strategies, and taxonomic relationships.

Place is a space that includes “its physical, biological, ecological, and cultural features” (Lutts, 1985, p. 38).

Photovoice is a “process by which people can identify, represent, and enhance their community” through documentary photography (Wang & Burris, 1997, p. 1).

Sense of Place is “a person’s cognitive, affective, and embodied understandings of a place that are cultivated through a living ecological relationship with the place” (Lim & Calabrese Barton, 2010, p. 329). It includes place attachment, the importance of a place to people (Grove & Burch, 1997; Jorgensen & Stedman, 2001; Low & Altman, 1992), and place meaning, how a place becomes part of a person’s or group’s identity and the reasons for attachment (Devine-Wright & Clayton, 2010).

CHAPTER II

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

The purpose of this chapter is to review the literature in the fields of science education and environmental education (EE) with respect to issues of equity and identity. I begin this chapter with a review of the literature on scientific literacy and examine how science education scholars have addressed equity issues.

Next, I briefly present the history of EE to establish its connections with science education. Then, I discuss environmental literacy and compare and contrast environmental literacy and scientific literacy. I then examine equity issues in EE.

After establishing the connections between science education and EE with respect to literacy and equity issues I present the conceptual framework for my dissertation, Critical Environmental Agency (CEA), and explain how I developed this conceptual model based on the literature in science education and EE.

History of Scientific Literacy

Though there is agreement that students need to be scientifically literate in order to compete in the twenty-first century global marketplace, there is not agreement on what being scientifically literate means (Bybee, 1997; Deboer, 2000; Hodson, 2008; Roberts, 2007). As Roberts (2007) observes, “there is no consensus about the meaning, or even the constituent parts, of SL (scientific literacy)-with one exception; everyone agrees that students can't be scientifically literate if they don't know any science subject matter" (p. 735). Hence, science knowledge appears to be necessary, but what else is needed for one to be scientifically literate?

Debates surrounding scientific literacy have engaged scholars for more than two centuries (Bybee, 1997; Deboer, 2000; Oliver et al., 2001). In fact, debates about which aspect (knowledge, skills, or dispositions) should receive the greatest emphasis in K-12 schooling have driven science education reform efforts for the past forty years (Oliver et al., 2001). Yet, scholars such as Bybee (1997) have asserted that scientific literacy should be the paramount goal of education.

The term scientific literacy became widely used in the United States in the late 1950s (Dillon, 2009; Hodson, 2008; Oliver et al., 2001). With the Russians' launch of Sputnik in 1957, going to the moon was of utmost importance to the United States. President Dwight D. Eisenhower's initiative, the National Defense Education Act, placed science and mathematics education at the forefront of U.S. education (Bybee, 1997; Deboer, 2000). Yet, science during this time was considered a subject only needed for the most intellectual students, who were likely to have careers in the sciences (Tan et al., 2012).

Science education continued to be of national concern when in April 1983, *A Nation at Risk: The Imperative for Educational Reform*, was released. This report commissioned by President Ronald Reagan, informed the general public that

> individuals in our society who do not possess the levels of skill, *literacy*, and training essential to this new era will be effectively disenfranchised, not simply

> from the material rewards that accompany competent performance, but also from the chance to participate fully in our national life. (p. 2, emphasis added)

The report concluded that U.S. science education standards were not rigorous enough as evidenced by “a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977” (1983, p. 11). The committee believed that the low academic performance of U.S. students was contributing to the decline of the U.S. economy; thus, reforms in education were needed.

Two years later, the American Association for the Advancement of Science (AAAS) convened a panel of scientists, mathematicians, and technologists “to identify what was most important for the next generation to know and be able to do in science, mathematics, and technology—what would make them science literate” (AAAS, 2013). *Science for All Americans* (1989) was a result of this panel. This book defines a science-literate person as,

> one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes. (p. ii)

The late 1980s brought about reforms in education that promoted science for all and a push for equality began to ensue. The National Academy of Sciences focused on promoting scientific literacy for all students, and in 1996, The National Research Council published the *National Science Education Standards*. As DeBoer (2000) indicates, “the objective of the National Standards was for all students to achieve scientific literacy by mastering a set of content standards" (p. 591). Most recently, The National Research Council (2012) developed *A Framework for K-12 Science Education*, which was steeped in the most recent research on science and science learning and proposed specific science content that K-12 students should know.

From this framework, *The Next Generation Science Standards (NGSS)* was published in 2013, which comprises the newest set of national science content standards. Though the Framework and NGSS do not explicitly define scientific literacy, the writers of these documents draw upon the definitions found in *Science for All Americans* and the *National Science Standards* (see Table 1), and they believe the goal of science education for all students is to

> have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology. (p. 1)

Knowledge-centered Scientific Literacy

The definitions provided in Table 1 have a common theme of defining scientific literacy as a system of knowing. If one knows and understands scientific concepts and processes, then one is deemed a scientifically literate person. Roberts (2007) labels this type of scientific literacy "Vision I," while B.A. Brown, Reveles, and Kelly (2005) call it the "knowledge-centered perspective."

Table 1

Summary of Scientific Literacy Definitions

Publication	Definition
Science for All Americans (1989)	• Familiar with the natural world and respect its unity • Know key concepts and principles of science • Have a capacity for scientific ways of thinking • Know that science, mathematics, and technology are human enterprises, with strengths and limitations • Use scientific knowledge and ways of thinking for personal and social purposes
National Science Standards (1996)	• Ask/ Determine answers to questions about everyday experiences • Can describe, explain, and predict natural phenomena • Can read and understanding science articles in the popular press and engage in social conversation about the validity of the conclusions • Identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed • Evaluate the quality of scientific information on the basis of its source and the methods used to generate it • Pose and evaluate arguments based on evidence and apply conclusions from such arguments appropriately
Oliver et al. (2001)	• Be familiar with scientific content knowledge (facts, concepts, and processes) and scientific ways of thinking and understanding (the history and nature of science and social aspects of scientific practice)
Framework for Science Education (2012)	• Know, use, and interpret scientific explanations • Generate and evaluate scientific evidence and explanations • Participate productively in scientific practices and discourse • Understand the nature and development of scientific knowledge

Note. *Next Generation Science Standards*' definition is built upon the *Framework for Science Education*'s definition.

In their article on re-examining scientific literacy, Eisenhart, Finkel, and Marion (1996) challenge the assumption put forth by knowledge-centered scientific literacy, and they argue that teaching students scientific concepts, processes, and practices does not guarantee socially responsible engagement or diverse participation in socio-scientific issues.

Thus, identity issues arise as diverse students, who have been historically marginalized and denied access to the science pipeline, are expected to become scientifically literate simply because they are provided with the same materials, instruction, and learning spaces as non-marginalized student populations.

Problems with Equality in Science Education

Though examinations of equality issues in science education have shed light on the limited access to science students in low-income urban and rural areas experience (Calabrese Barton, 2007; Oliver, 2007), equality research only illuminates "whether opportunities to learn exist for all students (i.e. equal treatment) or whether all students are achieving in science and math, and if not, where the achievement gaps exist or persist (i.e., equal outcomes)" (Tan et al., 2012, p. 7), while not exposing issues of equity and access.

Yet, even when students have access to the same content and level of instruction, student affiliation with and for science varies. In their ethnographic study, Carlone et al. (2011) examined two fourth grade teachers, with equal amounts of teaching experience (Mrs. Sparrow, 4 years experience, and Mrs. Wolfe, 5 years experience), both fiercely committed to inquiry-based science practices. The classrooms were equally diverse and located in Title 1 schools in the same school district, but very different cultural definitions of "science" and "science person" were apparent in these two classrooms.

Mrs. Wolfe's class' cultural definition of "science" and "science person" involved collaborative testing, sharing ideas, and producing questions, while Mrs. Sparrow's class celebrated individual knowledge and ideas. When asked to identify the "smart science student" in the classroom, 33% of the students in Mrs. Wolfe's class identified themselves, and 67% identified with at least one attribute of the "smart science student." In contrast, when asked to identify the "smart science student," 27% of Mrs. Sparrow's students identified themselves. When asked if they identified with at least one attribute of the "smart science student," only 27% of Mrs. Sparrow's students answered in the affirmative. Thus, 46% of the students (who were all students of color) did not specify any characteristics they had in common with the "smart science student."

Though both teachers demonstrated best practices and students from both classrooms had high performances on standardized science tests, Mrs. Wolfe's students demonstrated a greater science affiliation than Ms. Sparrow's students. In this example, providing comparable access to science content instruction did not guarantee that students experienced equitable learning, as Ms. Sparrow's class did not push against the tightly defined boundaries of what it means to be scientific nor did it challenge who is deemed scientific.

As seen in the above study, student identity work is multifaceted, and various researchers analyze identity in a multitude of ways (Gee, 2000). For the purpose of my study, identity is defined as the "kind of person one is recognized as being, at a given time and place" (p. 99, Gee, 2000). If the recognition of what it means to be scientifically literate is narrowly defined, then students will have fewer opportunities to develop their science identities, which enable them to see themselves as scientific and capable of doing science. Hence, issues of equity and access must be explored in order to better understand how to leverage diverse youths' engagement and agency in developing scientific literacy and science identities.

Equity in Science Education

Many equity scholars (Brickhouse et al., 2000; Brickhouse & Potter, 2001; B.A. Brown et al., 2005; B.A. Brown, 2004; Buck, Cook, Quigley, Eastwood, & Lucas, 2009; Calabrese Barton & Tan, 2010; Carlone et al., 2011; Carlone, 2004; Olitsky, 2006; Rahm & Ash, 2008; Tan & Calabrese Barton, 2008; Tsurusaki et al., 2013) have challenged the narrow view of science presented by raising issues of marginalization experienced by culture, language, and gender groups and by critiquing the power structures that enable these inequities.

In the article *What Kind of a Girl Does Science? The Construction of School Science Identities*, Brickhouse et al. (2000) conducted an ethnographic study of twelve, seventh grade African American girls, who self identified as interested or successful in science. The authors analyzed how their social identities overlapped with science identities, and for the purpose of their article, they selected four exemplary case study students from the larger data set, who displayed the diversity of identities and affiliation with science. As Brickhouse et al. noted, "The tasks for students are to decide which groups they identify with, what kinds of persons they wish to be as a part of each group, and what is required to become those kinds of persons" (p. 444). By observing the social groups that the girls participated in as well as their classroom interactions and by conducting personal interviews, the authors were able to ascertain how the students characterized themselves in relation to science, how they carried these science identities into their social groups, and how the culture created in the classroom positioned the girls in relation to science.

Sheela, one of the four exemplary case study students, complied with the social role of good student (such as being quiet and raising her hand to answer questions) and was able to assimilate successfully into the science classroom. Even though she viewed herself as good at science, she did not think she would be a good scientist. Sandy, another young woman, was gifted at problem solving and analyzing how things work, which aided her in laboratory experiments. Yet, this identity often competed with her perceived academic talent (she failed several of her seventh grade classes because she did not turn in required assignments), which at times limited her engagement in the classroom. Tanisha, a third student, was a leader in the classroom, and both her peers and teacher recognized this. However, her social identity was often in conflict with a good student identity, despite her competence in science. Candra, the fourth case study student was highly sociable with average academic achievement. Her social skills enabled her to succeed in science despite the fact that her answers and contributions to classroom discussions exhibited less depth of understanding than the other three girls. Though each girl had a different social identity, Sheela and Candra were the most successful in the classroom and most readily adopted a good student identity of compliance and took up the typical social roles and talents afforded to girls in our society. Compliance is viewed as a more feminine characteristic in schools, and girls are often expected to be quiet rule followers (Scantlebury & Baker, 2007). This suggests that girls, who do not take up stereotypical feminine gender roles, might struggle with access to success in science, which is an equity issue.

In his 2004 study, Brown studied the ways students used discourse to communicate their science identities and how this aided or limited the assimilation of minority students into the culture of science. Brown collected data from one high school science classroom, where he served as both the classroom teacher and educational researcher. He analyzed his data by coding individual discourse to determine,

> (1) students' challenges to the epistemological position that was reflected in the science curriculum; (2) students' willingness to participate in the normative linguistic practices of this particular science classroom; and (3) students' discursive conflict in attempting to incorporate science discourse. (p. 818)

Four discursive science identities emerged: Opposition status, Maintenance status, Incorporation status, and Proficiency status.

Avoidance of science discourse characterized students who displayed Opposition status. Even though some students had the ability to utilize science discourse, they were committed to maintaining their normal discourse and thus were identified as Maintenance. Other students readily attempted to adopt science discourse, which displayed an Incorporation Status. Finally, there were Proficiency Status students who engaged fluently with the scientific discourse. Brown observed that though students were willing to engage in challenges to their epistemologies (their basic beliefs about scientific knowledge such as when the first humans appeared on Earth) they were less willing to incorporate science discourse. He accounted for this lack of willingness on the part of students to be a product of the tension of their science identities and their cultural identities, which illuminates equity issues with a knowledge-centered view of scientific literacy.

In a similar study, Brown et al. (2005) presented a case study from a fifth grade classroom of African American students. They explored the connections between students' science identities and scientific literacy by conducting a detailed discourse analysis of video data taken from a 2-day classification lesson. The data were part of a larger yearlong ethnographic study. The authors found that the teacher often recognized one student, Damon, as a "knowledgeable science person" as she praised his responses. In contrast, James, another student in this classroom, did not receive this status even though his contributions to the classroom discourse were equivalent to Damon's. Instead the teacher commented to the class, "So understand, some people know more about science than they let on" (p. 796). Thus, the teacher positioned James as someone who hides his scientific knowledge. The authors believe that the teacher and peers interpreted Damon and James to be different types of people, with one being recognized as scientific and one surprising people when he participated in the scientific discourse. They argue that this recognition has the potential to influence the development of students' scientific literacy as students respond to peers' and teachers' recognition of their abilities (Brickhouse et al., 2000; Brown, 2004). When students fall outside the accepted model of smart science student, they struggle to receive recognition for their efforts and scientific achievement is often deemed impossible.

Buck et al. (2009) also explored the issues of achievement through an explanatory sequential mixed methods study of science attitudes, experiences, and understandings of urban African American girls from low SES communities. The participants in the study were selected based upon their attendance at an all-girls academy, and participation in the project was extended to all students in grades 4-6. All girls who chose to participate in the initial survey (n=89) represented similar socioeconomic status and were African American. A purposeful sample of girls (n=30) was selected; that sample represented the three grade levels (fourth, fifth, and sixth) as well as the three academic levels (low, average, and high) of students, determined by statewide assessments in English and Math.

In the quantitative portion of the study, the participants completed the modified Attitudes Toward Science Inventory (mATSI). These results yielded four science attitude profiles. Low and high values were determined by splitting the scores at the midpoint (3.5) on the Likert scale. The descriptive statistics did not explain the variances within the survey results, which further supported the use of the four profiles. Most of the girls (69.7%) fit within the high desire/value and high confidence/non-anxiety profile. The next largest group (16.8%) was the high desire/value and low confidence/non-anxiety profile, and roughly 10% of the girls were in the low desire/value and high confidence/non-anxiety profile. Finally, only 3.4% of the girls were in the low desire/value and low confidence/non-anxiety profile.

The four science attitude profiles were then used to inform the qualitative portion of the study. Four major themes emerged from the girls' interviews: definitions of science, importance of science, experiences with science, and success in school science. Two categories emerged within the definitions of science: girls either expressed science as content-driven (n=16) or as a discovery process (n=14). The importance of science was coded into three subthemes: importance for personal needs (n=12), importance for school advancement (n=12), and little importance (n=6). Eighteen out of the 30 girls had experiences with science outside of the school setting, whereas 10 girls reported that they only had experience with science in school. Success in school was influenced by previous success and perceived ability to obtain help from the teacher; thus, the subthemes were "very successful/can succeed with help" and "too frustrated to succeed."

Linking the quantitative and qualitative data enabled the authors to further explain the four science profiles. They were able to obtain thick, rich descriptions from the group interviews, and the researchers combined the analyses to determine personal orientations toward science. Thus, high/high girls had a high value for science but were motivated either intrinsically or extrinsically. Intrinsically motivated girls described science as directly connected to their personal lives, as a process, and had experiences with science outside of school; however, extrinsically motivated girls described science as content, important for advancement, and only had science experiences in school. The low/high group's confidence was also linked to their success in science but science was not of interest to them. The high/low girls were frustrated with the classroom process of science because they could not get the right answers and did not understand how to achieve the correct results. Finally, the low/low group was frustrated with science. Their only experience with science was inside the classroom, and they viewed science as content to be memorized. However, the majority of the girls in the study were high in their confidence and their desire/value to learn science even though their achievement in science was low. Thus, further research is needed to tease apart the disparity between students' perceptions and students' achievements.

In a longitudinal study of informal settings and science learning, Rahm and Ash (2008) conducted an ethnographic study of four ethnically diverse students over a four-year period. Two of the students came often to the aquarium with their parents, while the other two students participated in an after school science program. The uniqueness of this study was that the researchers were concerned with disenfranchised youth, who the authors define as ethnically and linguistically diverse with historically limited access to science, rather than youth who already identified science as an area of interest. Thus, the authors argued that this study filled a gap in the literature because

> Most studies have focused on academically strong students who are already serious about a scientific career, and who face few obstacles of access to science. Yet, we know that the same opportunities in science are particularly crucial for ethnically and linguistically diverse youths from low-income backgrounds who rarely see themselves as insiders to that world. (p. 50)

While concentrating on equity, the article also focused on the students being able to develop identities that allowed them to move from outsiders to insiders in relation to the science. Lave and Wenger (1991) described this as legitimate peripheral participation, which occurs as "the learner's presence is legitimated in the eyes of the members of the community" (Ben-Ari, 2005, p. 367) as newcomers move toward more central roles. Thus, legitimate peripheral participation affects how individuals are able to present themselves and how they are viewed and treated by others (Ben-Ari, 2005; Lave & Wenger, 1991; Lemke, 2001).

In this regard, Rahm and Ash found from their interview and observations of Franco, who visited the museum with his parents, that "several meaningful learning opportunities in a marine discovery center had helped Franco to develop an identity as a 'novice' science scholar" (p. 52). However, Franco seemed to lack confidence to talk about school science with his parents, and he had fewer opportunities to participate in hands-on activities or field trips than the other participants in this study. Eva, the other participant whose parents also brought her to the aquarium, was quite articulate about school science and had multiple experiences with science in and out of classrooms. Eva continually saw herself as someone who could "do science" and "be anything" (p. 57). Eva acted as the tour guide for her parents, and unlike Franco, she talked continually about her experiences with science.

Next, Rahm and Ash interviewed two girls who participated in an after school program that helped them develop science fair projects. Samira wanted to ask questions that helped her learn, while Nisha wanted to experiment to have fun with science. Samira stayed in the after school program for three consecutive years, while Nisha only stayed in the program for one year. For Samira, science was a gateway for future success and the afterschool program provided an entry point. For Nisha, the program allowed her social opportunities with her friends but did not increase her affiliation with science.

In comparing the four youths, Rahm and Ash concluded that Eva (aquarium visitor) and Samira (after school program participant for three years) had similar affiliations with science that allowed both girls to be able to see themselves as students who do science. In contrast, Franco (aquarium visitor) and Nisha (participant in after school program for one year) were often left at the margins of science and did not necessarily see themselves as individuals who could do science. This study demonstrates how students can have similar science-learning experiences, like Eva and Franco or Samira and Nisha, but develop different views of what it means to do science. The importance of this study centers on the development of thick, rich descriptions of marginalized youth who engage in out of school science. The authors of the paper would argue that making assessable science-learning environments for all youth is of paramount importance and despite that there were different outcomes for the four participants out of school learning experiences are critical for youths' views of what it means to do science and be scientific. Therefore, the question arises of how to develop science-learning environments that are accessible to all youth and promote multiple views of what it means to be scientific.

Sociocultural-centered Scientific Literacy

Using the research from equity scholars, a second type of scientific literacy has developed, Vision II (Roberts, 2007) or the sociocultural-centered perspective (Brown et al., 2005). Unlike Vision I or knowledge-centered scientific literacy, which divorces knowledge and skills acquisition from social and cultural settings, Vision II scientific literacy perspective promotes scientific literacy as "the modes of interaction and sociohistorical contexts brought into play in the construction of how and why individuals within communities take up science" (Brown et al., 2005, p. 780).

Sociocultural-centered scientific literacy acknowledges that learning occurs within a social context as "an ongoing, integral part of our lives, not a special kind of activity separable from the rest of our lives" (Wenger, 1998, p. 226). Thus, learning involves the entire person actively participating in social environments, where individuals work to negotiate new meanings from communal practices and appropriate these meanings in ways that further develop conceptions of self. It is the process of becoming and "transforms our ability to participate in the world by changing all at once who we are, our practices, and our communities" (p. 227). As Wenger observes, "learning –in whatever form it takes– changes who we are by changing our ability to participate, to belong, to negotiate meaning" (p. 226). Thus, sociocultural theory provides an opportunity to view learning as the process of becoming, which requires one to engage in and understand the culture and practices of the community (Lave, 1996).

As Tan et al. (2012) observe, the sociocultural-centered perspective "transforms the goal of promoting science for all from assimilation to enculturation" (p. 36). Learning becomes a form of participation in everyday and disciplinary practices and is mediated through the roles individuals choose or at times are assigned by others in the community. Lave and Wenger (1991) describe the ways in which individuals participate in groups and negotiate their roles as legitimate peripheral participation, which occurs as "the learner's presence is legitimate in the eyes of the members of the community" (Ben-Ari, 2005, p. 367). The ways in which individuals are able to engage affects how individuals are able to present themselves and how they are viewed and treated by others (Ben-Ari, 2005; Lave & Wenger, 1991; Lemke, 2001). Thus when students are enculturated into science through legitimate peripheral participation, students are encouraged to take up the discourses and practices of science, which influence their views of themselves.

For instance, in their case study of two young women of color, Brickhouse and Potter (2001) found that Crystal and Ruby "experienced both marginalization and participation in school communities of science and technology practices" (p. 977). After moving to a suburban middle school, Crystal struggled in her all white eighth grade honors science class, and in order to succeed in the class, she felt that she had to conform to the culture of the school and blend into the all white classroom by not drawing attention to her African-American heritage. This experience led her to choose an urban technical high school, where she felt that she was more readily able to participate in her classes, as the students were more like her. In order to succeed in her Advanced Chemistry class, Ruby also had to conform to classroom practices, such as only asking procedural questions and not more critical questions of the content, which limited her participation. In contrast, Ruby was able to successfully participate in her computer class due to her out of school experiences with computers. Thus, the two young women were both constrained and aided in their identity formation by the discourses, practices, and culture of their classroom communities.

In an ethnographic study of girls in an Active Physics class, Carlone (2004) found that even though some of the girls embraced the identity of an Active Physics student, this type of science identity did not translate into the girls further developing their general science identities. The 10 girls who positioned themselves as “lab people” still did not label themselves as “science people” at the end of the term, choosing not to pursue upper level physics courses. “Lab people” were students who enjoyed hands-on activity and real world problems. They found the student roles available in the Active Physics to be more exciting and interesting even though these roles demanded them to take risks and engage more with the curriculum. Four of the 14 girls actively contested the identity of “lab person,” and they were very vocal during their focus group interviews on how they were opposed to learning physics through active instruction. These affordances and constraints demonstrate how “the process of enculturation is thus fairly complex and fraught with many equity-related concerns” (Tan et al., 2012, p. 37).

Critical Science Literacy

Though the sociocultural-centered perspective of scientific literacy acknowledges inequities students face, it still promotes students’ enculturation into the practices of science and limits students’ ability to leverage their own funds of knowledge and experiences (Tan et al., 2012). Yet, youths’ lives are affected by science on a daily basis. Whether it is deciding what to eat for lunch or choosing what types of clothing to purchase, youth use scientific information to make decisions even if they are not explicitly cognizant of that fact.

Therefore, it follows that youths’ lives are engrained in science. Scholars have shown that youth are more engaged when science is shown to be relevant to their lives (Barnett et al., 2006; Calabrese Barton & Tan, 2010; Wheaton & Ash, 2008). Thus, youths’ lives belong in science and their experiences should be utilized in the classroom, and critical science literacy envisions such a goal by moving "beyond monolithic narratives of school science and math to incorporate how individuals in their everyday lives appropriate scientific ideas and thinking, and to merge them with other understandings, personal knowledge, and practical experiences" (Tan et al., 2012, p. 40).

Similar to the other two perspectives of scientific literacy (Vision I concentrates on knowledge and skill acquisition while Vision II adds social and cultural aspects to Vision I), critical science literacy still advocates for the development of knowledge, practices, and skills; however, the purpose of learning science is steeped in Freire's (1970) concept of problem-posing education, in which students "develop their power, to perceive critically *the way they exist* in the world *with which* and *in which* they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation" (p. 9).

Critical science literacy entails: (1) transformation of spaces where students learn and do science, (2) transformation of the discourses and practices of science and classrooms, and (3) transformations of students' identities (Tan et al., 2012). Socio-scientific issues, controversial social issues related to science (for example, genetic engineering of crops or animal testing for medical purposes) are often used to promote critical science literacy.

Though it did not specifically address critical science literacy, Olitsky's (2006) study on how a school district's label of 'college-bound' influenced a group of students' discourses on what students should and should not be taught in science can be used as an example of students engaging in critical science literacy. Olitsky interviewed and observed a group of eighth grade female students in order to analyze their discourse in relation to the teachers' and the school district's official and unofficial discourses concerning students who attended college and those who did not. Through the girls' dialogues with each other, she found that an "identity associated with school science was more likely if the students were identified as college-bound" (p. 763). Thus, it would seem that the dominant discourse discouraged non college-bound students from developing science identities. However, two of the girls in the study, who were not college-bound, resisted this dominant discourse, which implied they did not need science. They attributed this to the culture produced in their science classroom, which conveyed a view of science as accessible to all students whether or not they were college-bound. The two girls had the opportunity in their science classrooms to critically engage with the (1) content, (2) text, and (3) promoted ways of being scientific through the classroom discourse and practices. By having these experiences, they were able to critically explore who had traditionally been allowed to do science and how this notion needed to be expanded and challenged.

Using the principles of critical science literacy, Tan and Calabrese Barton (2008) used critical ethnography to explore how two Latina students, Ginny and Amelia, leveraged nontraditional knowledge of science and ways of being scientific to exhibit agency, which is defined as an individual's capacity to act within a given situation (Holland et al., 1998), in their science classroom. For instance, Ginny was able to use her love of music to complete an assignment in her science class, and Amelia utilized her out-of-school experiences to contribute to classroom discourse. The authors viewed the classrooms they observed as communities of practice, “where members are bound by specific ways of being endorsed by the science teacher” (Tan & Calabrese Barton, 2008, p. 48). By choosing to engage or not engage in practices that promoted the endorsed ways of being, students developed identities-in-practice, related to whom they were, who they could be, and who they desired to be, in their science classroom. Students’ agencies emerged as they struggled to author new identities-in-practice.

The study site was a low-income school in the Bronx where 90% of its students received free/reduced lunch. Since the school had a science focus, all 6th graders received five periods of science instruction a week. The teacher, Mr. M, was committed to his students learning science in pursuit of social justice, which aligned with the goals of the research. Data collection involved field notes, video, and semi-structured interviews of a larger case study of seven girls in which Ginny and Amelia were participants.

Ginny exemplified a successful student through her grades, popularity, and intellect, and she identified herself as being good at science. Amelia was not very popular and often was seen as a bully, but she also saw herself as good in science. Though Ginny and Amelia positioned themselves and were positioned by others differently in the classroom, both girls were able to use their experiences and cultural knowledge to achieve success in their science classroom while at the same time authoring identities-in-practice that aided in expanding who counted as a science learner.

For instance, the teacher encouraged students to make flash cards for key terms. However, for the bones test, Ginny utilized pop culture to create a song about bones based on a current radio hit. Copies of the bone song were made available to Ginny’s classmates, which enabled her to "extend the format of the learning tool the teacher endorses and possibly convinced him of the alternative forms of revision tools that are student-chosen and student centered, tapping into resources outside of the classroom" (p. 59). This example demonstrates how Ginny leveraged her agency in the classroom.

While Ginny was able to use her love of pop culture to broaden classroom practices, Amelia was also able to utilize her experiences on after school field trips, sponsored by the school, for students and parents to participate more fully in class. Mr. M had a strict set of classroom expectations, which included waiting to be called on and not talking over others, and at the beginning of the year, Mr. M labeled Amelia as a "problematic student." Yet, by the end of the year, Amelia was recognized by Mr. M as one of the most involved science students. Amelia was able to use her field experiences to give her status in the classroom and Mr. M began frequently asking Amelia to share her stories. This recognition and participation enabled Amelia to use her "loud" girl identity to transform the rules of classroom so that she could also contribute to class discussions on her terms.

By utilizing their own lived experiences, both girls were able to develop multiple identities-in-practice. They were able to exhibit agency in their science classrooms by engaging "both essential identities and noncommodified funds of knowledge not traditionally sanctioned by the science teacher" (p. 69).

Critical Science Agency (CSA)

As Roth and Barton (2004) ascertain, "science teaching must educate youths about the connection between sociocultural and scientific aspects of life, and it must provide opportunities for youth to participate in a practice of science in genuine social contexts" (p. 183). By providing youth a chance to engage with socio-scientific issues, they are afforded opportunities to engage in political action while also learning science. Thus, understanding how youths' lived experiences can be leveraged in service of robust and meaningful science learning and identity development exemplifies critical science literacy, which can in turn lead to critical science agency (CSA). CSA, as defined by Calabrese Barton and Tan (2008),

> …implies that students: (a) gain a deep understanding of science and the processes, skills and modes of inquiry associated with the content of science; (b) identify themselves as experts in one or more realms associated with the content of science; (c) and use science as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just. (p. 6)

CSA has been used to explore how diverse students exhibit agency through their participation in science and development of science identities (Basu et al., 2009; Calabrese Barton & Tan, 2010; McNeill & Vaughn, 2012; Tan & Calabrese Barton, 2008; Tsurusaki et al., 2013). As Holland et al. (1998) assert, "*identities* are hard-won standpoints that, however dependent upon social support and however vulnerable to change, make at least a modicum of self-direction possible. They are possibilities for mediating *agency*" (p. 4, emphasis added). In accessing what is needed for democratic science pedagogy (students help to shape curriculum and practices in the classroom), Basu and Calabrese Barton (2009) found that teachers and students saw CSA as essential to establishing democratic science classrooms. In particular, students displayed desires for expertise and excellence, which is the first principle of CSA.

To further develop the CSA framework, Basu et al. (2009) examined how ninth graders positioned themselves in a high school conceptual physics classroom in ways that afforded increased community participation. Three perspectives were incorporated into this critical ethnography: (1) teacher-researcher, (2) student-researcher, and (3) university-based researcher. Data were collected in multiple ways. The teacher-researcher kept a teaching journal with weekly reflections, and she conducted semi-structured interviews with five students who had a broad range of interests, abilities, and engagements. In addition, she also spoke with the participants' family members to better understand their family structures. These students participated in think-alouds where they discussed ideas for experiments and class lessons. Student work was collected as well as grades, attendance records, classroom observations, conversations, and planning notes. The students also wrote reflections about their life and family histories, experiences in school science, what they were learning in physics, their future aspirations, and their ideas for improving their physics class. Two students (Neil and Donya) became the focus of this article in that they represented contrasting case studies.

Neil, a recent immigrant from St. Lucia, struggled to pass the ninth grade. He was interested in a science career and participated in robotics development; yet at the beginning of the year, he was disruptive in class and his fellow students resented his disruptions as it impacted their learning. Donya was an honor roll student, who desired to pursue a career in law, and she actively participated in class and after school activities such as track and field and GlobalKids (a group designed to help youth be activists).

Both students' expressions of CSA were tightly bound to their science identities. As Neil became more involved in the world of robotics, he began to see himself as a doer and thinker, and his peers began to positively recognize his expertise. The continuing development of his science identity allowed him to display his creativity, passion, and ability in his robotics science fair project. He also was able to design a curriculum unit on robotics that he helped to co-teach the next year, and he built a strong social support network by participating in local university robotics competitions, which gave him access to a larger network of peers, who had similar interests, and university professors, who possessed greater expertise. Donya expanded her science identity through inquiry and the challenge of teaching her peers. She helped co-plan a lesson on black holes and dark matter, and she leveraged her future aspirations in law to bring debates into lessons. In her science fair project, she embraced the challenge of constructing multiple hypotheses and enjoyed designing experiments to test how objects float. She also challenged the stereotypes of black urban students by pursuing the toughest concepts in physics and performing with confidence and expertise. Thus, identity development, leveraging resources, and envisioning one's future self enable students to experience CSA. This process is both iterative and generative in that a person is constantly reflecting upon and modifying her identity and knowledge base. As her knowledge base expands, her expertise and influence grow, which affords more access to social and cultural capital.

Another example of using CSA as an analytical lens is a critical ethnography conducted by Calabrese Barton and Tan (2010), which explored how students came to understand urban heat islands (UHIs) and how they transitioned from novices to community experts. The context in which the researchers conducted their study was "Get City," a year round after school science club, that met at the local boys and girls club and had 40 student participants, ages 10-14.

The authors originally designed activities for "Get City" that resembled lessons that would have occurred in an inquiry-based science classroom. The students at first enjoyed these activities. Yet, as the weeks progressed, the students expressed their desire to take what they were learning and apply that knowledge by conducting research in their community. Thus, using input from the students, the researchers altered their plans and designed community investigations. The projects allowed the students to develop questions about UHIs in their communities. Soon, the students became aware of the differences between "their side of town" and other areas in town. The temperatures they measured were higher on their side of town and there were also fewer trees and fewer greenspaces, which led the students to speculate why this inequity was present. After further investigations and interviews of community members, the students realized that people were unaware of the UHI effect, so they produced public service announcements (PSAs) about UHIs, describing the environmental and health problems that could occur due to the UHI effect. The students presented their PSAs to city officials, which led to the PSAs being broadcast on the local public television station. Through the PSAs, the youth were able to position themselves as community science experts, who knew science, communicated their ideas to others, and used their scientific knowledge to take social action by highlighting the UHI effect in their community, which was higher than in other areas of the city.

As the above examples exemplify, CSA affords scholars the ability to better understand how students attempt to use their own lived experiences in service of science learning. It allows researchers to consider: Whose view of science is being privileged? Whose view of science is being silenced? How are students' everyday experiences in and with science being leveraged? How are they constrained? What types of identities-in-practice are enabled for individuals? What types of identities are constrained?

Yet if all three aspects of CSA ((a) deeper content knowledge; (b) recognize self as expert; and (c) opportunities to engage in change and/or action) are not considered, then the above questions cannot be addressed. For instance, in their study of CSA of urban students in regards to climate change education, McNeil and Vaughn (2012) only addressed the first and third principles of CSA. They did not attend to participants' identity development, and they narrowly defined principle three as personal actions taken to combat climate change. The study took place in three high school capstone classes focused on urban ecology. Data were collected from pre/post-tests with focal students (n=22) being selected for pre/post 15-20 minute interviews to understand their knowledge acquisition and subsequent behavior changes. Students did have an overall significant increase in their understanding of climate change over a six-week unit, and most students reported an increase in environmental actions (such as using CFL bulbs and conserving energy). However, McNeil and Vaughn did not discuss the students' science identity or how their identities changed over time. There is no indication as to what type of science person was promoted and how this enabled or constrained students' engagement with the curriculum or their participation in environmental action. By not utilizing an identity framework and narrowly defining principle three, the authors' assertion that the students' developed their CSA is not robustly supported.

As the above example demonstrates, it is essential for scholars to attend to all three aspects of CSA in order to advance the literature base of CSA. Yet, McNeil and Vaughn's study, focused on environmental science education, does illuminate an area where CSA has not been explored, environmental education (EE). Though EE is often equated to environmental science education, Carter and Simmons (2010) explain the distinction between these fields: "Environmental science is the engine of data collection and knowledge creation, while EE is the vehicle for dissemination and application of that knowledge with environmental literacy as the ultimate goal" (p. 13). Though the environmental sciences are foundational to EE, EE goes beyond the acquisition of knowledge and skills associated with environmental sciences and incorporates how to use scientific knowledge to encourage behavioral changes and actions that will help develop a more environmentally aware public, leading perhaps to a less degraded natural world.

The Gap in the Literature

Most of the research to date in EE uses a psychological perspective, viewing learning as a process that occurs solely within the mind of the individual (Devine-Wright & Clayton, 2010). Sociocultural views of identity development, viewing learning as a process that occurs within social and cultural groups, are scarce in the EE literature (Stets & Biga, 2003). As EE and environmental literacy are becoming more of an international effort, important questions regarding equity, access, and identity need to be addressed. Therefore, incorporating CSA into EE research would not only broaden the research on equity, access, and identity but also expand and widen the sociocultural and critical theory literature bases in EE. Critical theorists address social and cultural norms in order to expose inequalities and instances of oppression. CSA also affords a critical lens through which to examine diverse students' participation in EE by enabling researchers to consider how students' everyday experiences in and with the environment are being leveraged to develop recognized ways of being a successful EE participant who engages with socio-ecological issues (societal issues that are caused by ecological problems that have multiple causes and multiple possible solutions). Thus, my study fills a gap in the literature by using CSA to construct a framework for researching EE settings.

Brief History of EE

EE is rooted in nature study, conservation education, and outdoor learning education movements from the 19th and 20th centuries (Carter & Simmons, 2010; Disinger, 1985). In 1962, Rachel Carson's *Silent Spring*, a book that exposed the unintended environmental consequences of using a pesticide (DDT) for mosquito control, awakened a new awareness in the U.S. general public. The 1960s protest culture greatly influenced the public's growing concerns about environmental issues (Gouch, 2012; Rome, 2003), and over the next decade, many national environmental policies (such as The Wilderness Act, the Species Conservation Act, the Clean Air Act, the National Environmental Policy Act, and the Clean Water Act) were implemented. In 1969, Stapp became the first scholar to succinctly define EE as, "aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution" (p. 31).

A national survey of U.S. schools and districts, conducted by the National Science Teachers Association (1970), revealed that there were only 54 programs with any EE component. In response to the apparent lack of EE and the establishment of the National Environmental Education Act in 1970, the National Association of Environmental Educators (later renamed North American Association of Environmental Education) was founded in 1971 (Disinger, 2001). The National Environmental Education Act presented EE as "the educational process dealing with man's relationship with his natural and manmade surroundings, and includes the relation of population, conservation, transportation, technology, and urban and regional planning to the total human environment" (*Environmental Education Act*, 1970, p. 1), and by 1980, there were EE specialists in every U.S. school district (Carter & Simmons, 2010).

In 1976, the first EE framework was developed. Known as the Belgrade Charter, this document summarized the goals, objectives, and principles of EE. The Belgrade Charter still supplies us with the most widely accepted definition of EE:

> Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones. (UNESCO-UNEP, 1976, p. 2)

One year later, the Tbilisi Declaration was written in order to provide the goals that EE should strive to achieve. The three goals are stated as,

> (a) to foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;
> (b) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
> (c) to create new patterns of behavior of individuals, groups and society as a whole towards the environment. (UNESCO, 1977, p. 26)

As indicated in the Belgrade Charter and the Tbilisi Declaration, EE involves not only scientific understanding but also encourages people to make decisions for the good of society and nature, with the goal of producing environmentally literate citizens, that is people who have the ability to make informed environmental decisions and the capacity to act on their decisions. This interdisciplinary nature of EE is also reflected in one of the earliest definitions of EE found in the literature:

> EE is a process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulating of a code of behavior about issues concerning environmental quality. (Martin, 1975, p. 21)

Equity Issues in EE

Though EE is interdisciplinary and encourages environmental literacy for all, there have been many equity issues associated with its brief history.

Access to Nature and Greenspaces

Both ethnicity and socioeconomic status seem to impact participation in outdoor activities (Warren, Roberts, Breunig, & Alvarez, 2014). Poor people and people of color have been less involved in the EE movement (K. Allen, Daro, & Holland, 2007; Taylor, 1996, 1997). Several studies (Cilliers & Siebert, 2011; Iverson & Cook, 2000; Pauleit &

Golding, 2005; Tratalos, Fuller, Warren, Davies, & Gaston, 2007) have documented that the distribution of greenspaces and vegetation biodiversity is not uniform across socioeconomic gradients; there are more greenspaces and more tree cover in wealthy areas. Hope et al. (2006) coined the term “luxury effect,” which is the tendency of people with higher socioeconomic status to inhabit areas with higher amounts of biodiversity. This is accomplished either by the wealthy creating biodiversity hotspots themselves or by them selecting neighborhoods with naturally high biodiversity.

Environmental Justice

Inequity occurs not only in regards to access to biodiversity; it also occurs in issues of environmental degradation and human health concerns. In regards to human health concerns, the environmental justice movement has worked to highlight how “environmental damage happens disproportionately in poor, working-class, and minority communities” (Martusewicz, Lupinacci, & Schnakenberg, 2010, p. 13). In a meta-analysis conducted by Mohai (1985), he found a correlation between environmental degradation and race; ten out of the eleven studies Mohai examined had found significant bias. In addition, five of the studies found racial biases to be more significant than socioeconomic factors.

Several other studies have concluded that communities populated by people of color as well as low socioeconomic status experience a disproportionate burden of environmental hazards (Bullard, 1993; Mohai & Bryant, 1992; Pellow, 2000). For example, in Detroit, Michigan, asthma rates were three times higher than the national average particularly among poor African American children (Akinbami, 2006). As

Pellow (2000) stated, “these hazards may include polluting industrial facilities and a host of other locally unwanted land uses such as incinerators, landfills, and land smelters, for example” (p. 587).

Diverse Participation Issues

In addition to environmental justice issues and limited exposure to nature, non-dominant groups have not been readily represented in the environmental sciences or environmental groups (Taylor, 1996, 1997). Historically, the phrase “white, middle class, tree hugger” was a stereotype that characterized many people involved in EE (K. Allen et al., 2007). In 2002, NAAEE publicly recognized the need to diversify EE by composing a diversity statement, which was revised in 2007.

> NAAEE recognizes the integral connections between environmental concerns and wider questions of social needs, welfare, and economic opportunity. It also acknowledges the need for greater emphasis on equity and celebration of diversity within NAAEE and in the field of environmental education. (2007, p. 1)

Equitable Opportunities in Field Science

Despite the potential barriers for diverse youths’ participation in EE, I argue that field sciences could promote youths’ EE learning and literacy. As Hart (2010) recommended, EE has the potential to transform K-12 education because EE celebrates diverse perspectives and grapples with issues that are political in nature and involve deep philosophical considerations. In studies comparing 300 undergraduate students in a field-based class versus in-class learning and engagement (C. D. Allen & Lukinbeal, 2011; C. D. Allen, 2011), Casey Allen (2013) argued that fieldwork “has a strong capacity for increasing both science and non-science majors’ abilities to learn complex concepts, with the added benefit of actively engaging minority and female students in science" (p. 10). This increase in understanding scientific content aligns with the first principle of CSA (deeper understanding of science); thus, field science experiences, though largely overlooked by science education and social science scholars (Barnett et al., 2006, 2011; Bowen & Roth, 2007; Brodman, 2000), are conducive to developing youths' CSA.

Field sciences may serve to attract diverse students to science and EE, which is the impetus for my study. Since it does not have the perceived rigidness and narrow structure of laboratory sciences, field sciences might inspire youth to develop a deep understanding of the concepts and practices of field science (Bowen & Roth, 2007), which aligns with the first principle of CSA.

Field sciences may also afford youth the opportunities to quickly move to central aspects of participation (second principle of CSA) as weather patterns and study environments introduce obstacles that encourage the development of new strategies and ideas for data collection and observation. Finally, field sciences are also practical sciences that have direct bearing on youths' every day lives since the very existence of humankind is contingent upon the state of the ecosystem. As the ecology of an area is better understood, environmental problems (e.g. water and air pollution) can be better addressed, and the ecological health of a community (e.g. water and air quality) can be improved. These community benefits are similar to those provided by the health sciences, and studies have shown that diverse youth are apt to choose science careers that are altruistic in nature and serve the community in which they were reared (Fadigan & Hammrich, 2004). This supports principle three of CSA by providing students with opportunities for individual and communal action (e.g. community gardens and stream restoration) that can lead to the improved ecological health of communities.

Field Ecology

Bowen and Roth (2007) argue that a particular field science, field ecology, should be further explored in science education and EE as diverse youth might be attracted to the way science and EE are practiced in these settings, the sense of community that develops, and the sense of belonging that field ecologists experience. As Bowen and Roth note, field ecology does not have the perceived rigid, narrow structure of laboratory sciences; it presents science as a flexible, broad field of inquiry that includes laboratory and fieldwork. For example, given the complexity and variableness of natural systems, field sciences have more highly emergent research designs. Also, field scientists often have to engineer tools and tweak methodologies in the moment, which require creativity and ingenuity. In addition, Bowen and Roth maintain that field scientists develop a rich sense of community by swapping informal "tales from the field," which they use to communicate knowledge and share experiences. Thus, field ecologists recognize storytelling as scientific knowledge since this is often how they converse in the field. Finally, field ecology is similar to health science fields in that students have opportunities to choose science careers that are altruistic in nature and serve their community (Fadigan & Hammrich, 2004). Though Bowen and Roth provide thick, rich descriptions of field ecologists' research practices, there is little literature on diverse youths' participation in field ecology programs (Barnett et al., 2006, 2011).

Field ecology and its practices are not stressed in the *Next Generation Science Standards* (NGSS Lead States, 2013; G. W. Scott et al., 2012), so unless a teacher has experience with field ecology, diverse students might have limited exposure to the practices of field ecology in a K-12 science classroom. Thus, out of school, informal learning settings (e.g. museums, nature centers, and science camps) might be able to serve as sources of possible introductions to field ecology. The National Research Council consensus report on informal science learning concluded that informal science settings support "science learning for virtually all people that is conducive to learning systematic and reliable knowledge about the natural world" (Bell, Lewenstein, Shouse, & Feder, 2009, p. 2). Informal settings, where students not only freely choose to participate in science learning but also seek out the opportunity, have also been identified as possible venues for students to further their scientific inquiry as well as deepen their affiliation with science (Dohn, 2011; Falk, Heimlich, & Foutz, 2009; Fields, 2009; National Science Board, 2007; Rahm & Ash, 2008; Rahm, 2002, 2007; Wheaton & Ash, 2008).

Coupling an EE field ecology program designed for youth with educational research offers a new setting in which to explore equity, diverse youth, and CSA, as most studies have focused on university settings (Alagona & Simon, 2010; C. D. Allen, 2013; Bowen & Roth, 2007; Sukhontapatipak & Srikosamatara, 2012). This type of setting can aid in understanding how diverse students come to see themselves in relation to EE. It is important for EE researchers to understand the practices used in different disciplines and how these practices afford or constrain diverse youths' affiliation with EE. It is also important for policy makers, administrators, and educators to understand what disciplines are best suited for equitable education, so that the practices from these disciplines can be utilized in the classroom. Thus, my study explores the ways diverse youth enact and take up the practices of field ecology in a 4-week herpetology research experience (HRE).

Herpetology

As an avid student of field ecology in both my undergraduate and graduate studies, I myself experienced CSA within the context of herpetology (the study of amphibians and reptiles). During my undergraduate studies, I worked closely with herpetologists on field studies on the Panamanian golden frog (*Atelopus zeteki*) and on the Great Smoky Mountains stream salamanders (first principle of CSA: deepening knowledge and skill). As an environmental consultant, I worked to preserve wetlands and riparian zones, essential habitats for amphibians and reptiles (second principle of CSA: identity development). As a science educator, my students and I worked together to increase community awareness about the ecological value of amphibians and reptiles, referred to as herps (third principle of CSA: opportunity to make world more just).

Brodman's (2000) study of college students engaging in field surveys of amphibian populations aligns with my personal experiences. Brodman used students' exam scores and research records to determine if the course objectives of learning techniques for field surveys and determining critical aspects of habitat were met. Sixty-three percent of the students scored above 90% on the final exam, and students' desire to do fieldwork increased as 73% of upperclassmen took the class multiple times and 22% of the juniors and seniors were engaged in amphibian research for three years. In fact, students who engaged in amphibian research had a 91% retention rate in biological and environmental sciences compared to the overall 79% for the major. Brodman believes amphibians make model organisms for field science investigations because they are harmless, relatively easy to capture and breed, and provide a context for multiple biological concepts (e.g. development, conservation, ecology, and behavior). He also asserts that engaging students in fieldwork can acquaint them with using science to explore problems in the local community.

Calabrese Barton and Yang (2000) discovered that herpetology was one way that Miguel, a twenty-six year old homeless father, pursued his interest in the natural world. He became a self-taught herpetologist, managing a small herpetology breeding business. "Miguel expressed concern that neither his middle school nor high school valued the experiences which he found meaningful in his own life even when those experiences carried academic overtones" (p. 878). This indicates that typical classroom teachers may overlook herpetology as a legitimate source of academic learning.

Most recently, Carlone et al. (in press) found that herpetology afforded students opportunities to engage with the practices of field ecology even though the youths at first experienced fear when in nature and working with the amphibian and reptiles. As students began to work through their fears, they began to affiliate more with herpetology, the environment, and the organisms. In their ethnographic study of the 4-week summer HRE that occurred two years before my study, the authors discovered that all 15 participants (high school students, ages 15 – 18) engaged in some form of identity boundary work (confronting boundaries between certain types of identities – for instance, moving from not being an "outdoors" person to being an "outdoors" person). Thus,

Carlone et al. explored the tools and normative practices that allowed youth to engage in these settings, and they proposed four themes (the exemplar of each theme is italicized):
(1) Boundary objects were tools that regularly facilitated youths' participation and aided them in working through fear or discomfort. For example, participants were first introduced to snakes in aquaria, which allowed the students to examine the snakes up close, while having a *layer of glass* between them and the snakes.
(2) Time and space allowed the instructor to be responsive to students and enabled students opportunities to adapt to new environments, new organisms, and new field ecology skills. For example, the instructor offered youth *multiple opportunities to handle animals* throughout the course and this provided time and space for students to decide when they were ready to hold an organism.
(3) Social support and collective agency encouraged the participants to work together through their fears. For instance, when two youths volunteered to check the first aquatic turtle trap, other youths on the shore were *telling them to be careful, reminding them to help the other person, and encouraging them* to take their time so they did not fall.
(4) Scientific and anecdotal knowledge and skills broadened how students experienced science in this setting. One instance of this occurred when an aquatic turtle trap had a snapping turtle in it. The students instantly moved away from the trap, but as the instructor *explained why* the snapping turtle looked as it did, the students began to move toward the trap and examine the once feared creature.

These results suggest that exposure to field ecology and herpetology might provide opportunities for youth to engage in sustained identity work (i.e. negotiating who one is able or not able to become in certain settings and how one is perceived by one's self and by others in those settings).

Carlone and colleagues (in process) further research identity-related issues in their examination of three HREs. They explore how youth discussed being smart in the HRE compared to how youth discussed being smart in school, especially in school science, and how youths' descriptions of self (with respect to how they view themselves in the HRE and how they themselves in school science) have both similarities and differences with the HRE and school science. The authors examined how students defined smartness in the HRE and smartness in school science by asking participants to list the three smartest students in the HRE and the three smartest students in their school science class and describe why the students they named were smart. Next, the students were asked if they shared any characteristics with the smart students in each setting. Prior to these questions, participants were asked to describe themselves in the HRE and in school science. The authors found that participants more readily used language indicative of enjoyment and engagement when describing themselves and their experiences in the HRE. Three themes emerged in relation to the HRE versus school science: (1) meaningful and joyful engagement versus compliance; (2) learning as growing versus learning as static achievement of knowledge; (3) learning as a social and nurturing endeavor in service of others and/or the environment versus learning as an individual endeavor in service of individual achievement. These findings suggest that experiences such as the HRE might aid in challenging the dominant narrative of smartness in school science (e.g. innate ability, knows all the answers, etc.) and provide pockets of opportunities for students to experience broader definitions of smartness such as helping others, thirsting for knowledge, and knowing how to capture and hold animals.

Though field ecology practices have been shown to align with CSA and promote identity development, little educational research has been conducted in field ecology and herpetology (Bowen & Roth, 2007; Brodman, 2000). This may be partly due to the fact that field ecology and its practices are not central in the *Next Generation Science Standards* (NGSS Lead States, 2013). Educators also claim they do not have time to take students outside (Endreny, 2010); thus, field ecology is not typically integrated into traditional school science in the United States. Since field ecology is not a focus in the traditional classroom, I chose to study an informal learning context that focused on field ecology and herpetology.

Summary of Literature Review

In the previous sections of this chapter, I provided a historical context for scientific literacy in the US. My emphasis on the equity issues and identity research in science education provides a framework in which to better understand equity issues in EE and how identity research can illuminate how students are positioned and position themselves in EE programs. Additionally, I examined CSA and the possibilities it affords for youth to engage in and affiliate with science. In the following section, I develop the conceptual framework that will guide my investigation.

Conceptual Framework

Every educational study is based upon some theory of learning, and my study is grounded in a critically orientated sociocultural perspective, which is built upon sociocultural and cultural theories and "describes learning as a situated practice shaped by the social, cultural, and political environment in which it takes place" (Basu, Calabrese Barton, & Tan, 2011, p. 8).

Sociocultural Theory

Sociocultural theory has developed as researchers have analyzed how people engage in learning outside of the typical classroom environment (Greeno, 1989). Early studies noted that people did not analyze and solve problems as they had been taught in the classroom. Instead, people responded based upon the social and cognitive practices provided by the context in which they worked (Cobb & Bowers, 1999), further evidence that their thinking was situated within the social context that they were in. For example, a person training to be a field ecologist must learn how to interact with various organisms, design field investigations, and collect relevant and accurate data. Yet, traditional classroom instruction provides field ecology students with fixed laboratory procedures that usually have one correct answer, and students rarely design and implement their own investigations. In contrast, a research internship at a field station provides training that is authentic, allowing students to observe experts and engage in actual fieldwork while simultaneously learning through apprenticeship (Cobb & Bowers, 1999).

This evidence, that people do not solve problems in the real world the same way as they do in a classroom, is supported by the assertion that "it is quite possible to acquire a tool but to be unable to use it" (J. S. Brown, Collins, & Duguid, 1989, p. 33). For instance, students can know an algorithm solving a problem, but be unable to use this "tool" outside the classroom. For example, students learn to measure length in elementary school yet when asked to measure the dimensions of a Box Turtle, students are often unsure of how to proceed. Thus, people appear to learn within the communities in which they live and work. Wenger (1998) has described these social contexts as communities of practice and goes on to discuss how everyone is involved in multiple communities of practices. As J. S. Brown et al. (1989) explained, these communities of practice "are bound by intricate, socially constructed webs of belief, which are essential to understanding what they do" (p. 33).

Therefore, as Wenger (1998) observes, "learning –in whatever form it takes– changes who we are by changing our ability to participate, to belong, to negotiate meaning" (p. 226). Thus, learning is an interaction between a person and a social context and not an activity located solely in a person's mind (Greeno, 1989). The key features of a sociocultural approach are authentic activities that involve the uses of tools and domain specific language that encourages identity work through social interaction (J. S. Brown et al., 1989). Given these features, sociocultural theory provides opportunities to view learning as the process of becoming, requiring one to engage in and understand the cultures and practices of the community (Lave, 1996).

Critical Theory

The ultimate goal of critical theory is to reveal power dynamics within community cultural practices and expose how these power structures benefit certain groups while oppressing others. Thus, critical theorists work toward emancipation of the less powerful by questioning the power structure and those in positions of privilege (Phillips et al., 2005). Critical researchers search for ways to expose how power is hidden and ideas are justified. In addition, critical scholars also ask such questions of their own research and try to be transparent in what interests their research serves and examine how their research is possibly perpetuating some dimension of power.

Critical education scholars have used critical theories to illuminate inequalities and injustices that are occurring in education. Students are not blamed for school failure or underachievement; rather, these are attributed to social and structural processes that perpetuate these outcomes. One such critique of the U.S. system is that "the economic system is unequal and unfair (in power, wealth, opportunity, and so on). Schools mirror that system, are subordinate to it, determined by it, and therefore function to reproduce it" (Gibson, 1986, p. 47). If education is taken from the top-down (e.g. legislator dictating curriculum) and those in power determine curriculum, then education becomes a mechanism to sustain the status quo instead of providing freedom and liberty for the educated (Freire, 1970; Rossatto, 2008). Freire addresses this type of education in his *Pedagogy of the Oppressed* and deems it the "banking" concept of education. The students are expected to simply listen, receive instruction, and store information that the teacher provides. In contrast, a "problem-posing" concept of education envisions students and teachers learning together as they consider real world issues and problems. They "come to see the world not as a static reality, but as a reality in process, in transformation" (p. 83).

Building upon the work of Freire, critical education scholars advocate for social justice and define these educational experiences as empowering education, which is similar to equitable education in that all students are valued and provided access. Yet, empowering education strives to further students' learning by providing opportunities for students to foster change in the world, the classroom, and themselves, which is akin to Freire's problem-posing education. Dewey, in 1916, also realized this political aspect of education as he recognized that societies would cease to exist if newborn members were not properly educated into the ways of the society. However, Dewey does not address, as Freire does, the political aspect of society educating children to sustain the culture and ways of the society. For instance, whose values should be taken up in the current situation of globalization that the world is moving toward? With this view, education becomes a very political act, as children are taught how to be a productive member of society.

Thus, a critically orientated sociocultural perspective pushes scholars to resist overgeneralization by not making the assumption that group cultural and social characteristics apply equally to every member of the group (Gutiérrez & Rogoff, 2003).

Environmental Literacy

Following in the steps of CSA scholars, who use CSA as a framework for examining critical science literacy, I intend to use my conceptual framework to examine environmental literacy. As indicated in a position statement by the National Science Teachers Association (2003), "environmental education (is) a way to instill environmental literacy" (p. 1), which exemplifies the sentiment of how environmental literacy was used in 1969 to promote environmental education (C. E. Roth, 1992).

Environmental literacy first became a focus in the United States when President Richard Nixon addressed Congress in his 1970 Environmental Message,

> It is also vital that our entire society develop a new understanding and a new awareness of man's relation to his environment - what might be called "environmental literacy." This will require the development and teaching of environmental concepts at every point in the educational process. (p. 11)

Seven years later, Hungerford and Tomera (1997) introduced the concept of action as part of the requirements for environmentally literate citizens, as “citizenry that is both competent to take action on critical environmental issues and willing to take that action” (p. 10). In 1989, Rockcastle described “a broad spectrum of environmental literacy, from total ignorance or unawareness to deep, thorough understanding and concern” (p. 8). Following Rockcastle, C.E. Roth (1992) proposed a continuum for Environmental Literacy, based upon knowledge, values, behaviors, and actions. In his continuum, C.E. Roth developed three levels or degrees of environmental literacy: nominal, functional, and operational. Nominal environmental literacy requires one to understand the basic scientific concepts of EE and how ecological systems and humans interact, and it includes the notion that the development of environmental awareness and sensitivity is increasing. Functional environment literacy builds upon nominal, with one deepening her level of understanding and engagement in EE by critically examining environmental issues and relating the information to others. Finally, operational environmental literacy combines knowledge, values, behaviors, and actions to engage the public in EE.

In this regard, NAAEE (2011) developed four key elements of environmental literacy in their framework on assessing environmental literacy:

> (1) the knowledge and understanding of a wide range of environmental concepts, problems, and issues;
> (2) a set of cognitive and affective dispositions;

> (3) a set of cognitive skills and abilities; and
> (4) the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts. (p. 2-3)

Environmental literacy is similar to scientific literacy in that it promotes knowledge and understanding of environmental concepts, as well as skills and practices associated with the environmental sciences. Yet, as Carter and Simmons (2010) observe, "environmental literacy requires knowledge and skills that both build upon and go beyond the environmental sciences" (p. 13). Thus, environmental literacy goes beyond scientific literacy in that knowledge from other disciplines (such as economics, political science, and history) is also needed (Roth, 1992). Environmental literacy also addresses affective dispositions and behavioral choices, which are not included as a part of scientific literacy (Roth, 1992).

In regards to conceptual understanding and disposition shifts, both formal and informal EE programs have been shown to influence these parameters (Iozzi, 1984; McBeth, Hungerford, Marcinkowski, Volk, & Cifranick, 2011; McBeth & Volk, 2010; Rickinson, 2001). Scholars have also researched instructional approaches, such as environmental action research and environmental service learning, to better understand how they aid in youths' participation in environmental issues and decision making (Coyle, 2005; Marcinkowski, 2004; Rickinson, 2001; Schusler & Krasny, 2010; Volk & McBeth, 1997; Zelezny, 1999). Yet, identity development has not been explored in environmental literacy research. Thus, considering identity development from a critically-oriented sociocultural perspective offers a needed lens for researching student participation in EE. Youths' ability to position themselves and how they are positioned in relation to the subject matter, practices, and cultural norms, offers new insights into how youth succeed or fail in becoming a member of an EE community. Therefore, CSA is an identity framework that could further our understanding of youths' environmental literacy. In addition, since EE and environmental literacy are contingent upon one's understanding of the environment, place-based and sense of place research also informs my conceptual framework.

Place-based EE

Place is an important concept in EE; however, it, like identity, has mostly been researched through a psychological and positivist perspective (for example, how an individual feels about a place or how a place makes a person feel (Kudryavtsev, Stedman, & Krasny, 2012). Lim, Tan, and Calabrese Barton (2013) also acknowledge the importance of place in CSA,

> Place matters because it orients science schooling in particular ways – it imbues the learning of science with certain expectations, practices, values, and materials. Furthermore, place matters because it positions youth in unique ways toward science learning: How youth are positioned socioculturally, politically, and geographically shapes how and why students and their teachers might choose to engage in science or in how they assign meaning or value to it. (p. 192)

Though scholars have used place to further their understanding of CSA, it is not a central principle of CSA. However, EE scholars have discussed how place might motivate people to become more knowledgeable about the environment, which may lead to changes in disposition and actions.

When discussing place, it is helpful to first define what is meant by place, as there are many different definitions among scholars from various disciplines (e.g. geography, EE, and outdoor education), who conduct place research (Endreny, 2010). I define place as a space that includes "its physical, biological, ecological, and cultural features" (Lutts, 1985, p. 38).

Place-based education began as an initiative for rural education and is described as immersing "students in local heritage, culture, ecology, landscapes, opportunities, and experiences as a foundation for the study of language arts, mathematics, social studies, science, and other subjects" (Place-based Education Evaluation Collaborative, 2010). Place-based education has been shown to encourage the use of schoolyards, communities, and local greenspaces, and it aids in fostering students' connections to nature and their communities. Established in 2001, the Place-based Education Evaluation Collaborative has

> instituted individual and cross-program evaluations of ten place-based education programs representing more than 100 schools (rural, suburban, and urban) covering twelve states. The body of evidence reflects more than 1,000 adult interviews or focus group participants; more than 250 student interviews; more than 900 educator surveys; more than 2,700 student surveys; extensive document review; and dozens of on-site observations. (2010, p. 1)

The Collaborative's findings indicate that place-based education improves students' academic achievement as well as heightens their environmental and social concerns. The University of Colorado at Denver's Children Youth and Environments Center for Community Engagement (2012), compiled the findings of several place-based education studies and reports and determined that place-based education helps students achieve higher test scores and grades, improves critical thinking skills, increases motivation, and creates more responsible behavior and environmental stewardship.

Research on Place-based EE

As indicated in the Collaborative's findings, place-based EE scholars have researched many educational topics (e.g. student achievement and motivation). Thus, for this purposes of this study, place-based research on environmental awareness, equity, and connectedness to nature was explored. These three research areas were chosen as they provide evidence for how focusing on place can afford diverse students opportunities to engage with EE.

Environmental awareness. Using a sequential explanatory mixed methods research design, Barnett et al. (2011) used pre/post-surveys and individual interviews to evaluate the ecological, economic and social benefits of greenspaces for urban students. Additionally they investigated the impacts of the built environment on the natural ecosystem. The researchers conducted a summer institute for secondary students (n=59) who had a C grade point average. Over the course of the two-week program, students participated in either the bird bioacoustics project or the urban street trees project.

In the bird bioacoustics project, students identified urban birds and recorded their songs along with the ambient background noise. Using RAVENlite, a free bioacoustics software analysis program created by Cornell Lab of Ornithology, the students analyzed the spectrograms of their recordings to determine if the birds' songs were being altered by urban noise.

Students involved in the urban street tree project used CITYGreen to determine the economic value of each tree by identifying each tree and calculating the tree's carbon sequestration. Then, the students were able to model various scenarios such as predicting what would happen to the surrounding environment if trees were removed or if new trees were planted.

The results of this study indicated that the students' self-efficacy in science (perceived ability to be successful in science) showed a significant increase ($p < 0.01$), and there were no ethnic or gender differences. This result was surprising since previous research had shown that self-efficacy does not usually increase over a short time period, especially for females and minorities (NRC, 2004). The students' ecological mindset, defined as sense of environmental stewardship, also showed a significant increase ($p < 0.01$), and again there were no ethnic or gender differences. Students' science interest was high prior to entering the program and continued to be high throughout the program.

In another study, place-based pedagogy was used to teach a watershed unit in a fifth grade classroom (Endreny, 2010). Endreny's goal was to better understand how students' perceptions of the environment changed with place-based curriculum. In this qualitative study, teachers and researchers developed a yearlong watershed unit together and taught it to 33 students, the majority qualifying for free/reduced lunch and being of African American heritage.

Throughout the year, the students conducted investigations at their local creek such as conducting mini bioblitzs (survey of an area to attempt to identify all organisms within the area), performing water and soil quality tests, collecting weather data, and counting macroinvertebrates. The findings indicated that 93% of the students could accurately define a watershed when either interviewed or asked to write about a watershed. In addition, 62% of the students gave in-depth explanations of water pollution such as increased phosphates and nitrates coming from fertilizer usage. These same students were also able to identify all stages of the water cycle including infiltration and percolation. Finally, 89% of the students were able to connect biotic and abiotic factors to watershed quality and discuss how these factors were also affected when pollution entered or alterations were made to their watershed. All students came to view watersheds as present in urban environments, and the students were able to identify local animal and plant species that were associated with their watershed.

Equity. Barnett et al. (2006) conducted a two year long sequential explanatory mixed methods study that evaluated the development and implementation of a field-based urban ecology science program for diverse secondary students. A comparison group (students who had not participated in the Urban Ecology Institute) and an experimental group (students who had participated in the Urban Ecology Institute) were administered the modified Scientific Attitude Inventory II survey, and individual interviews were conducted with the experimental group to better understand the students' perceptions of the Urban Ecology Institute experience.

The results indicated that both males and females in the experimental group differed from their counterparts in the comparison group on post-survey responses regarding science affiliation and ecological mindset, which the authors define as students' sense of environmental stewardship ($p < 0.05$). Thus, students in the experimental group had higher affiliations for science and more positive attitudes on their post-surveys. These same students also had a greater concern for the urban environment and they better understood the ecological principles surrounding urban ecosystems.

Connectedness to nature. Sukhontapatipak and Srikosamatara (2012) evaluated students' attitudes towards campus wetlands and connectedness to nature after multiple class investigations in the wetlands. The two-year study involved third year biology students (n=50; n=64) enrolled in general ecology. Year 1 had two action projects addressing biodiversity and community ecology, while Year 2 had three action projects focusing on interspecific competition, species' niches, and biodiversity. Year 1 projects required 30% of the instructional time, and due to the added project in Year 2, 60% of the instructional time was used. Students completed an environmental attitude survey, and their field notes were analyzed for ecological understanding and attitude toward campus ecosystems.

In this sequential explanatory mixed methods design, researchers found that there was a difference in pre/post attitude scores for Year 1 and Year 2 ($p < 0.05$). Thus, environmental attitudes improved regardless of the time invested in the project. However, only Year 2 projects affected the students' negative perceptions about wetlands ($p < 0.05$), so more time was needed in the wetlands to change students' perceptions of wetlands as places of disease and pollution. Finally, all students indicated that the projects helped them appreciate the beauty of the campus, and the students had a deep understanding of ecological principles in regards to urban wetlands.

Critical Pedagogy of Place

As demonstrated by the above studies, using place as a basis for EE affords students with opportunities to connect to local places while developing deeper understandings of EE. If place is to be added as a principle of CEA, which is built upon CSA, a critical theory of place needs to be utilized in CEA. Thus, Greenwood's (2012; Gruenewald, 2003) critical pedagogy of place undergirds principle c (gain a deep understanding of place, leading to a critical consciousness of place) of CEA. It can be used

> to promote an awareness of differences and possibilities, and understanding of how things have come to be as they are and what they might have been otherwise. It must be used to enlarge horizons, to shake complacency, to stir the imagination. (Barrow, 1980, p. 83)

As Greenwood suggests, a critical consciousness of place is developed by learning to recognize environmental destruction and disruption (decolonization) and then applying this newfound awareness to learn to live socially and ecologically responsibly in these places (reinhabitation). He further recommends attending to three questions: "a. What happened here? (historical); b. What is happening here now and in what direction is this place headed? (sociocultural); c. What should happen here? (ethical)," (2012, p. 97) in order to focus on the historical, sociocultural, and ethical dimensions of the place.

The focus on decolonization and reinhabitation allows researchers to address both individual and collective views of place. The focus on the collective is unique in place literature, and it acknowledges that even if individuals are alone when they experience the place, they bring with them previous experiences, conversations and interactions with others in the place, which influences their attachment and meanings. Neglecting the collective leads to questions such as: How can individuals develop bonds and symbolic meanings without interactions with other people? How do these social interactions influence individuals' experiences? How do others recognize individuals in these settings? How do others contribute to the meanings made? What are the group experiences that have occurred in the place being researched or similar places? What meanings have the group made in these places? What practices occur when groups are in this place? What is the community's perception of the place? Thus, a critical consciousness of place should lead to further development of one's sense of place as one discovers the historical background of place, considers the socio-ecological aspects of the place, and ponders the ethical dimensions of coming to know the place, which is why sense of place is the fourth principle of CEA.

Sense of Place in EE

The development of sense of place is important because as Worster and Abrams (2005) suggest,

> When one has a developed sense of place, one possesses several characteristics which can be developed sequentially or simultaneously: (1) ecological knowledge of the place, which leads to ecological identity; (2) knowledge of the local institution/social context (social behaviors, structures and norms) which facilitates the development of a social identity; and (3) place attachment to a region. (p. 526)

Though the literature on sense of place is vast as Kudryavtsev et al. (2012) attest, sociocultural perspectives are scant among the research paradigms used to conduct research in this area (W. Scott, 2009; Stedman & Beckley, 2007; Williams & Patterson,

2007) even though as McKenzie (2008) states, “environmental issues are often cultural issues” (p. 361). Since my conceptual framework is grounded in sociocultural theory, then this is also the perspective I embrace when considering sense of place.

As Kudryavtsev et al. (2012) do, I define sense of place as place attachment, the importance of a place to people (Grove & Burch, 1997; Jorgensen & Stedman, 2001; Low & Altman, 1992), and place meaning, how a place becomes part of a person’s or group’s identity and the reasons for attachment (Devine-Wright & Clayton, 2010). In addition, I draw upon Lim's and Calabrese Barton's (2010) definition of sense of place, “a person’s cognitive, affective, and embodied understandings of a place that are cultivated through a living ecological relationship with the place” (p. 329), as it aligns with the four elements of environmental literacy set forth by NAAEE ((1) Develop understanding of environmental issues; (2) Develop affective dispositions; (3) Develop skills and abilities; and (4) Develop strategies to apply understanding make decisions in a range of environmental contexts).

Sociocultural Research on Sense of Place

Firey (1944) was one of the first social science scholars to consider how places affected cultural and social development. In his essay in the *American Sociological Review*, Firey discusses how land use is at times determined more by cultural values than by economic gain. He presents the city of Boston as an example since there are areas of the city that remain unchanged due to “the group values that the spatial areas have come to symbolize” (p. 140) even though these areas could be used for more industrious purposes that would provide more economic benefits to the city and the people. The area of the city that he highlights most in his article is Beacon Hill, a high-end residential area in the heart of the city. Firey discusses how Beacon Hill has kept its appeal over the past 150 years, and he attributes this to local stories and sentiment. Though he does acknowledge that group culture has helped to maintain this area, he does not really discuss what the group culture is, how it developed, or how it is evolving. With this being one of the first articles to recognize culture in regards to sense of place, Firey still, in the end, returns to a more psychological and positivist mindset as he credits most of Beacon Hill's popularity to steady real estate prices.

In 1976, Relph revived Firey's idea of group values determining the significance of places when he published his book *Place and Placelessness*. In his chapter titled, "On the Identity of Places," Relph distinguishes between identity *of* a place and identity *with* a place. "It is not just the identity *of* a place that is important, but also the identity that a person or group has *with* that place, in particular whether they are experiencing it as an insider or as an outsider" (p. 45). Relph goes on to explain how meanings can change and are not found in physical objects but rather determined by social interactions and experiences in the place. Though Relph does use a sociocultural perspective to discuss place identity, he does not present data in this chapter nor does he develop a framework, which others could use to conduct research.

How places develop meaning. Taking up the idea of place identity and meaning, cultural geographers have developed a geographical perspective on sense of place.

> The cultural process by which people construct their understanding of the world is an inherently geographical concern. In the course of generating new meanings and

> decoding existing ones, people construct spaces, places, landscapes, regions and environments. In short, they construct geographies. (Anderson & Gale, 1992, p. 3)

Combining this geographical perspective of place with sociocultural theory, Young (1999b) explored how places come to be regarded as tourist attractions through sociocultural constructions. Prior to this study, (Young, 1999a) researched the motivations people had for visiting the Daintree and Cape Tribulation area in Queensland, Australia, which is known for containing the largest block of virgin tropical forest in Australia, and he discovered people mostly attributed their motivations for visiting the area to tourist brochures, recommendations by others, the possibilities of outdoor adventures, and their own interests in the environment. Young used this research to compare the construction of place meanings to the motivations people had for visiting this area. He found that "tour brochures had little or no influence on how the Daintree and Cape Tribulation area was appraised" by tourists (p. 384). Place of origin and previous experiences in natural environments were the factors that most heavily influenced the place meanings attributed to the area. Young used positivistic methods including closed ended questionnaires and multivariate analysis to assess the differences between how the tourists presented place and how the tourists defined place. Young also spent more time discussing psychological motivations than discussing sociocultural meanings of place. In doing so, he neglected to discuss how individuals experienced the area, and he does not appear to be concerned with how people were recognized within the tourist groups (e.g. as novice travelers or knowledgeable travelers), presented themselves (e.g. as interested in the outdoors or seeking to increase their biological knowledge), or engaged in social interactions and group practices, which from a sociocultural perspective is needed to fully explore sense of place.

Use of social and ecological relationships. In their study of sense of place among New England fishermen and organic farmers, Worster and Abrams (2005) used a sociocultural perspective and qualitative methods (interviews and observations) to contribute to the conceptual understanding of sense of place in EE literature. The researchers discovered that all participants utilized their social and ecological relationships to aid the development of their sense of place. The participants' identities as fishermen and farmers strengthened their connections to the community and land, and their relationships with other fishermen, farmers, and locals were pivotal in their identity development as each participant repeatedly mentioned how others had contributed to their persistence in the community. In light of their findings, Worster and Abrams (2005) recommended, "environmental educators who integrate sense of place into their curricula should facilitate relationships between their students and the local social and ecological contexts" (p. 533), which aligns with sociocultural theory. They also believe that further research should be conducted with groups that do not utilize the environment in their profession to continue the conceptual development of sense of place.

Developing place attachment and meaning. Conceptualizing sense of place in terms of a child's insideness (how strong one's attachment is to a place), Lim and Calabrese Barton (2010) conducted an ethnographic study that explored urban children's development of place attachments in their communities. In defining insideness, they explain, "the essence of place experience lies in how one positions self in a place. The more the person is inside, the stronger one belongs to the place and identifies with the place" (p. 330). In using ethnographic methods, the authors departed from the positivist paradigm the other scholars used and embraced a critically oriented sociocultural perspective.

Their research study was conducted with 19 children at two public middle schools located in low-income areas of New York City. Data collection included conversational interviews, neighborhood walks, mapping, and auto-photography. An example of the authors emphasizing the children's meanings of and attachment to place was when they asked the children to define a neighborhood in their terms and then draw their neighborhood without providing them with any leading information such as boundaries to include or level of detail.

The authors observed that children's insideness had an effect on their environmental understanding, environmental competence, and affective relationships. In terms of their environmental understanding, children were able to develop contextualized, comprehensive, and critical understanding. For instance, children were able to discuss their neighborhoods in both positive and negative terms, which demonstrated that they deeply understood their environment. In knowing how to navigate in their neighborhoods and how to engage in different social settings and contexts, children were able to achieve environmental competence. When developing affective relationships in their neighborhoods, places often became symbolic to the children, and the children's meanings would not have been meaningful for an outsider or even a tourist visiting the community. For instance, Allegra, a student who paid close attention to animals and plants in her neighborhood, held a special affection for the tree outside her window claiming it was the oldest and largest tree in the neighborhood. Thus, the findings showed children were able to display agency in developing their sense of place through active exploration, multidimensional place meanings, and ability to engage with others. Though the authors of this study used sociocultural perspectives as their methodology, they still did not analyze children's group level interactions or collective meanings in their development of sense of place.

Influence on science learning. Lim et al. (2013) also utilized critically-oriented sociocultural learning theory to conceptualize place in science education. Though they do not discuss their research in terms of EE, the educational goals and outcomes of "Get City" project, a year round after school club for children, ages 10-14, to learn about green technologies, aligns with those of EE, and this affords me the opportunity to discuss their work in relation to sense of place and EE. In their discussion of "Get City," Lim et al. (2012) explore how students' participation with and in place influenced students' science learning in three different club activities: analyzing urban heat islands, making public service announcements about energy, and conducting a community survey for a local "Go Green" program.

The authors relied on critical ethnography (applying critical theory to ethnography in order to examine the implicit social and cultural values and explore how these values produce unacknowledged biases) to frame their analysis of individual and collective meanings of place and discussed how these meanings gave rise to tensioned dialectics (tensions between seemingly contradicting ideas). For example, one of the tensions that arose was between science and place. As the authors note,

> the doing of science is always situated by place – individuals located in time and space investigating an observable phenomenon. Yet, "place" is often invisible in the learning context as we abstract meaning from context to develop generalized patterns and explanations of the world around us. (p. 199)

However, unlike most school science, the "Get City" curriculum continually made place visible as students were asked to consider place in their questions and inquiry. For example, when asked if they would rather be under a shade tree or in the middle of a mall parking lot on a hot day, some students argued that they would rather be in the parking lot because it meant that they would be closer to air conditioning since they could walk to the mall. The researchers had assumed that all of the students would state that their preferences on hot days would be to be near shade trees; yet, the students relied upon experiences from their everyday lives to move the decontextualized spaces in the question to actual consideration of the desires and practices people would elicit in such a situation. Thus, this tensioned dialectic between science and place offered new ways for students to not only participate in but also to transform the "Get City" curriculum.

Critical Environmental Agency (CEA)

As demonstrated by the book chapter on place (Lim et al., 2013), most CSA scholars recognize the influence of place on students' CSA development, and they thoroughly address how place can both afford and constrain students' science learning and identity development. However, place is not an explicit principal within the CSA framework. So, if other scholars, like McNeill and Vaughn (2012), use CSA, place may or may not be considered. In fact, not only did McNeil and Vaughn not address place in their study, they did not discuss principle two of CSA (recognizing self as an expert). Thus, I believe that place and sense of place need to be more prominent when CSA is used in EE in order to capture these essential elements of EE.

In addition to the emphasis needed for place and sense of place, CSA was originally developed to better understand students' development of critical scientific literacy, and as mentioned above, even though there are similarities between scientific literacy and environmental literacy, there are also differences. Bearing these differences in mind, which are behavioral and dispositional attributes (i.e. students developing pro-environmental attitudes and engaging in personal environmental actions, such as recycling (Connell, Fien, Sykes, & Yencken, 1998), I argue that CSA must be expanded when it is applied to environmental literacy in order to consider the affective dimensions and range of environmental contexts. Therefore, I propose a framework of Critical Environmental Agency (CEA) (see Figure 1).

CEA implies that students:

> (a) gain a deep understanding of the sciences that informs environmental education and the processes, skills and modes of inquiry associated with the sciences;
> (b) identify themselves as experts in one or more realms associated with environmental education (such as environmental sciences, economics, and political sciences);
> (c) gain a deep understanding of place, leading to a critical consciousness of place (Greenwood, 2012);
> (d) strengthen their sense of place and demonstrate behaviors, actions, and/or individual and/or collective agency to consider, discuss and/or act on environmental issues (NAAEE, 2011);

> (e) and use EE as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just (Calabrese Barton & Tan, 2008).

Principles a, b, and e are taken directly from CSA (Calabrese Baron & Tan, 2008), and principles c and d build upon previous EE research on place and sense of place and connect it to identity development and environmental literacy (see Figure 1).

As shown in Figure 1, CEA is predicated upon two overarching ideas: (1) that students' lives *belong in* EE, thus *broadening* its practices and (2) EE *enriches* students' lives by *empowering* them with knowledge and skills that lead them to opportunities for CSA. By utilizing a place-based approach, EE can make place explicit, which aids in the students' development of a critical consciousness of place by exposing decolonization (the changing nature of the land and its inhabitants based upon human use and disturbance of the ecosystem) and enabling reinhabitation (learning to sustainably live with all inhabitants of the ecosystem) (Greenwood, 2012). A place-based perspective also deepens students' sense of place, leading to increased place attachment and place meanings. This enables students to make decision about and act on local environmental issues. By combining CSA with a place-based approach and incorporating a sense of place, CEA is developed and environmental literacy increases.

Summary: Conceptual Framework

To conclude, I have provided my conceptual framework for studying CEA in a summer herpetology program. Using sociocultural learning theory and a critical approach enables me to explore the meanings students make through their everyday interactions and experiences in EE. I specifically attend to youths' environmental literacy development and how they negotiate their experiences both in and out of the classroom. Careful study of how youth deepen their conceptual knowledge, engage in identity development, develop a critical consciousness of place, enhance their sense of place, and move toward social action will provide me with a better understanding of the affordances and constraints of EE for youth.

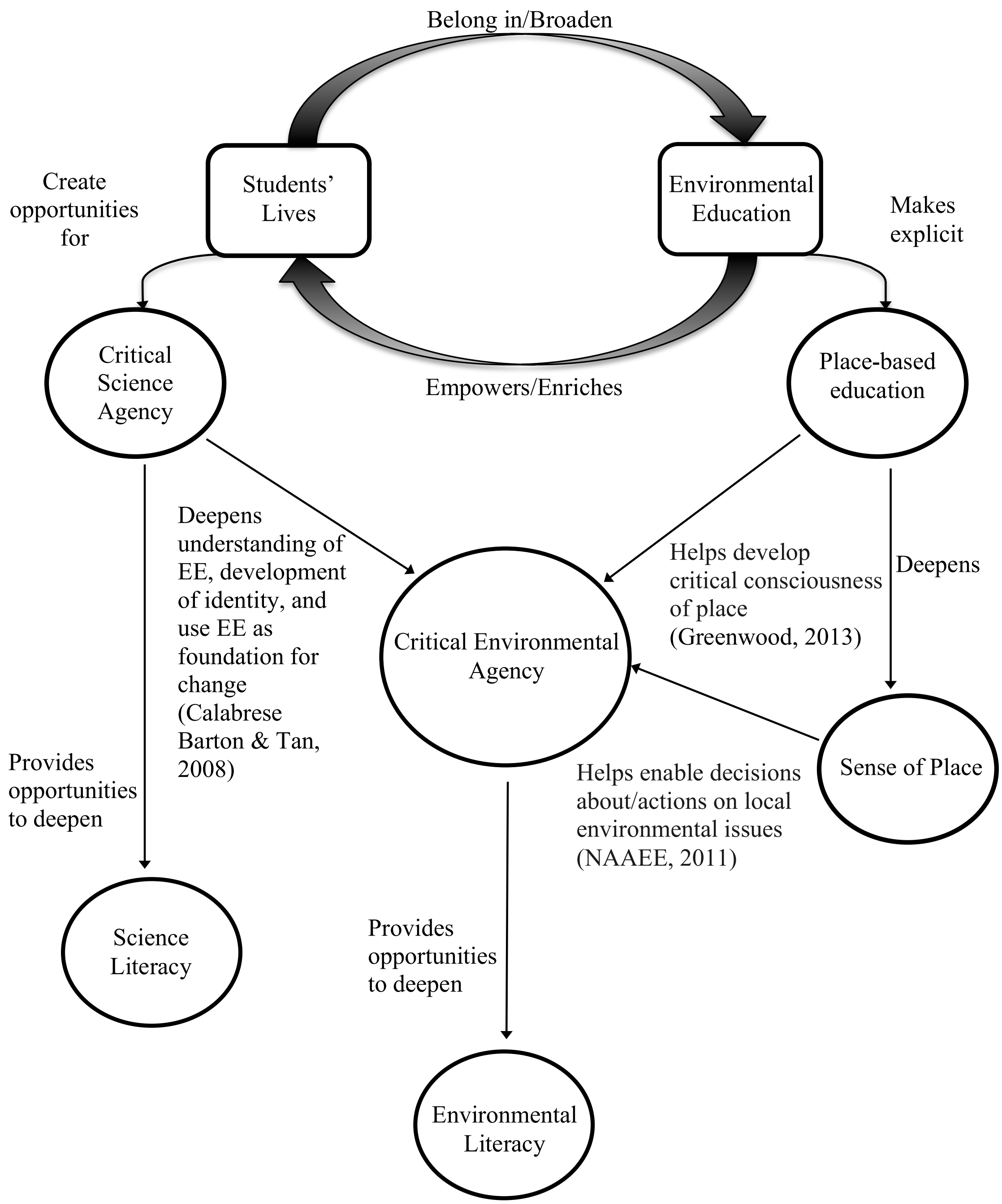

Figure 1. Conceptual Framework for Critical Environmental Agency.

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CHAPTER III

METHODOLOGY

The purpose of this study was to explore how Critical Environmental Agency (CEA) was enabled and constrained for diverse youth, during a herpetology research experience (Academy HRE). Bearing this purpose in mind, I had to consider research methodologies that would allow me to explore the meanings my participants made of the Academy HRE and how these experiences lead to the development of their CEA.

In this chapter, I explain the research methodology I used to conduct my study. First, I provide my research questions, which are the foundation for my data collection and analysis. Then, I explain my perspective and research approach based on my research questions. I continue by explaining my site selection and research setting, with a description of the grant (The HERP Project) through which the Academy HRE was funded. This is followed by a description of the Academy HRE curriculum. I also present an in-depth description of the photovoice project that Dr. T (the Academy HRE instructor) and I created, and I review the literature on photovoice methodology, tracing its beginnings in the health sciences to how it as been most recently used in science education and environmental education (EE). Next, I describe my 16 participants and provide a short vignette of each participant. I conclude this chapter with my research design, which also discusses the measures I took to assure validity of the study and the ethical considerations I addressed while conducting this research.

Research Questions

The overall goal of my study is to explore how diverse youth engage in EE. Thus, I constructed CEA, combining the three principles of CSA with two additional principles I gleaned from the EE literature. CEA is composed of five principles that imply participants:

> (a) gain a deep understanding of the sciences that informs environmental education and the processes, skills and modes of inquiry associated with the sciences;
> (b) identify themselves as experts in one or more realms associated with environmental education (such as environmental sciences, economics, and political sciences);
> (c) gain a deep understanding of place, leading to a critical consciousness of place (Greenwood, 2012);
> (d) strengthen their sense of place and demonstrate behaviors, actions, and/or individual and/or collective agency to consider, discuss and/or act on environmental issues (NAAEE, 2011); and
> (e) use EE as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just (Calabrese Barton & Tan, 2008).

These five principles have informed my work and led me to the following research questions.

1) How were youths' experiences leveraged to develop their CEA during the field ecology program?
2) How was CEA enabled during the field ecology program?
3) How was CEA constrained during the field ecology program?

Research Perspective and Approach

My research is situated within an interpretivistic tradition, which assumes meanings and understanding are developed socially and experientially. Interpretivism allows me, as a participant observer, to openly acknowledge, "the way we (as researchers) are part of the world we investigate, and the ways we make the world and change it." (Phillips et al., 2005, p. 66). Therefore, the participant meanings I am attempting to capture are "socially constructed, complex, and ever-changing" and are influenced by everyone in the setting including me, the researcher (Glesne, 2011, p. 8).

I used an ethnographic approach to better understand and interpret the meanings that my participants made of their experiences in the HRE and the cultural patterns that developed in the HRE. The ethnographic methods were "oriented toward the description and interpretation of cultural behaviors" (Schram, 2006, p. 95), and the long-term field immersion enabled me to develop "the thick description needed for getting at how people within a cultural group construct and share meaning" (Glesne, 2011, p. 19).

Site Selection

In his book, *Qualitative research design: An Interactive Approach*, Maxwell (2013) distinguishes between two types of site selection: a sampling approach and a case study approach. Though both have value, this study necessitated a case study approach, which justifies site selection based on my conceptual framework and goals of the study, which is to explore how CEA was enabled and constrained for diverse youth who participated in a field ecology program about herpetology.

Patton (2002) also suggests using case sampling in qualitative research, stating "the logic of extreme case sampling is that lessons may be learned more about unusual condition or extreme outcomes that are relevant to improving more typical programs" (p.232). Case sampling provides environments worthy of study, and because of the site's uniqueness, case sampling is able to illuminate both the unusual and the typical (Patton, 2002). This is in contrast to a sampling approach, which selects sites based on the ability to generalize results to a broad population. The selection of my study site aligned with CEA and the goals of my study: to understand the ways diverse students more deeply develop CEA, how the development of CEA is enabled and what constrains the development of CEA.

The Academy

Bearing this in mind, I conducted my research at a college access program (The Academy) located at a university in the southeastern US. The Academy serves academically promising high school students, who have significant financial need and/or who are potential first generation college students. The Academy's mission is to support these students in their development of academic and leadership skills with an emphasis on community, social awareness, and family involvement. The emphasis on community and social awareness were key factors for selecting the Academy as my research site, since CEA puts an emphasis on community and social action. In addition, the Academy supports these students (called scholars) who come from populations who are underrepresented on college and university campuses as they pursue higher education, build leadership skills, and develop an active sense of civic responsibility.

Established in 2007, the Academy accepts a new cohort of approximately 25 rising tenth graders during the summer of each year. All students must reside in the county where the university is located, and scholars are then selected to join the Academy via an application and interview process. The year-round college access program includes three 4-week long residential experiences on the university campus prior to the scholars' sophomore, junior, and senior years in high school as well as a monthly (September-April) Saturday Academy during the academic year. On average, 82% of the scholars, who enter the Academy, complete the college access phase of the program. Of this group, 100% are accepted into a college or university and 86% of those attend colleges and university in the state where the Academy is held. At the time of my study, the overall demographics of the Academy are 42% male and 58% female, with 32% African-American, 27% Caucasian, 30% Latino, 9% Multiracial, and 2% other.

During the month-long residential summer program scholars choose from as many as ten academic class electives that integrate reading, writing, speaking, and critical thinking skills and emphasize collaborative and organizational study and time management skills to increase potential for success in both high school and college. Each class meets four times during the week and lasts for two hours. The scholars take one class in the morning and one class in the afternoon. College visits to other universities occur once a week, and the scholars have designated time each evening for homework. The scholars go home on Saturday afternoons and return to the Academy on Sunday evenings.

The Herpetology Research Experience (Academy HRE) has been offered as one of the academic classes since 2010, and it usually has an enrollment of sixteen to nineteen scholars. In 2013, the scholars had a choice for morning classes of herpetology, criminal justice, neuroscience, food sciences, or financial management. The HRE was the only class that scholars were allowed to repeat, and the repeaters were referred to as SRAs (student research assistants). In order to be accepted for a second summer, scholars had to meet with the instructor and explain why they wished to take the class again and negotiate their roles in the class for the coming summer. Two repeaters (SRAs) were enrolled in the class of 19, and both SRAs agreed to participate in this study.

The HERP Project

The Academy HRE was one of three HREs (herpetology research experiences) funded by a National Science Foundation grant, *Herpetology Education in Rural Places and Spaces* (The HERP Project). The HERP Project's HREs are designed to introduce students to the field of herpetology through scientific investigations and field studies of Box Turtles, frogs, lizards, semi-aquatic turtles, snakes, and amphibians. Participants in the Academy HRE must be accepted first to the Academy and then they elect to take the HRE as one of their class options for the summer and then again for the academic year. Thus, participants for the Academy HRE do not apply for The Academy because of the HRE, whereas participants for the other two summer programs are applying to attend a program about herpetology. This is one reason why I selected the Academy HRE as the focus for my research. This provided an opportunity for participants who did not already identify with EE, field ecology, or herpetology to elect to take such a course as one course elective in a much broader-based program of college preparation.

Academy HRE

During the four-week summer residential program, The Academy HRE met two hours per day, four days per week. Three days were devoted to classroom activities while the fourth day was spent conducting a field science investigation (e.g. checking minnow traps, which are used to capture amphibians and reptiles, in an ephemeral pool). The course was designed to provide scholars with a foundational knowledge of the natural history of amphibians and reptiles as well as expose them to local reptile and amphibian species. Each week of the course concentrated on the habitat of the focus organisms and environmental threats and issues that the organisms were experiencing. Throughout the course, scholars learned to critically read and review a variety of materials including popular media, published scientific journal articles, and news resources. Scholars were introduced to field science careers, and they had an opportunity to meet and work with a number of herpetologists. During field investigation days, scholars gained experience in collecting, reporting, and interpreting scientific data.

The instructor for the program (Dr. T) was a science teacher educator at the university hosting the Academy, and in the beginning of the summer of 2013, Dr. T became the Director of the Academy. Formerly a middle school and high school science teacher, Dr. T holds advanced degrees in Biology (Masters) and Science Education (Doctoral) and has been working with high school students on similar types of projects for over ten years.

Academy HRE Curriculum. Over the four weeks of the Academy HRE, the students were introduced to herpetology, field ecology, and environmental concerns facing amphibians and reptiles. Scholars also participated in authentic herpetology studies and had opportunities to develop an understanding of the practices of herpetology, field ecology, and EE.

The HRE curriculum for week one offered a general introduction to herpetology, salamanders, and the photovoice project. Pre-tests of knowledge and pre-surveys of science attitudes, interests, and experiences were administered on the first day of class. There were two field investigations for week one. The first was a trip to a local urban park (City Park), where all the participants had been before, to search for Box Turtles with the aid of Boykin Spaniels, which had been trained to track and find Box Turtles. The second trip was to an ephemeral pool in an adjacent county, and during this trip, scholars interacted with a herpetology educator from a local university.

Week two curriculum introduced the scholars to the voucher project (a collaborative effort, began in 2012, with the Museum of Natural History to provide "missing" local herp specimens for the museum's herpetology collection (Tomasek, Huffling, Matthews, & Carlone, under review). Lizards and turtles were discussed this week, and the first photovoice focus groups (which are explained below) were conducted. A trip to University Forest (56 undeveloped acres adjacent to the University that have been protected since 2010) comprised the weekly field investigation, and the focus for this trip was on local habitat and ecology. A university biology professor, invited by Dr. T, accompanied the group into the forest.

Frogs were the focus of week three, and the state herpetologist, Mr. J, joined the class for two days. On Mr. J's first day, the class participated in a bioblitz (an event where teams of lay people and scientists work together to identify as many species as possible in a specific area over a specific time period) focused on herps that was held at one of the scholar's (Casey) houses. The next day Mr. J gave a talk on frogs and taught the students how to identify local frog calls, and the second photovoice focus group was conducted.

The final week of the program was devoted to snakes, the final photovoice focus group, and administration of the post-test and post-survey. In lieu of a field investigation, scholars performed a snake dissection with a partner.

Photovoice project. Prior to the 2013 Academy HRE, Dr. T and I developed a photovoice project, with the purpose of adding to the existing curriculum so that scholars would have more specific opportunities to further develop and deepen their CEA: (a) deepen understanding EE; (b) recognize self as expert in EE; (c) develop critical consciousness of place; (d) strengthen sense of place and discuss environmental issues; and (e) use EE for change and/or action. Photovoice is a participatory research strategy in which people use still cameras or video cameras to reflect upon the strengths and weaknesses of their community and themselves. These reflections, inspired by or enhanced with photography, trigger community members to enact social change (Wang & Burris, 1994). Photovoice projects typically emphasize community involvement with the aim of social action. In the following sections, I outline the history of photovoice, explain the methodology, discuss how photovoice has recently been used in science education and EE, and provide an in-depth description of the Academy HRE photovoice project.

History of photovoice. Wang and Burris (1994) first presented photovoice as photo novella and used it with 62 peasant women to promote women's reproductive and developmental health in rural China. It is based upon empowerment education, feminist theory, and documentary photography. As Wang and Burris (1994) originally describe, "The goal of photo novella is to use people's photographic documentation of their everyday lives as an educational tool to record and to reflect their needs, promote dialogue, encourage action, and inform policy" (p. 171-172). Empowerment education is achieved through facilitated discussion by which participants engage in critically analyzing their communities and social conditions that aid and detract from their community (Freire, 1970). Feminist theory reminds researchers that the research is done by and with the participants, who are the authorities of their own lives and have expert knowledge of their community. This is in contrast to investigations, which assume the researcher has the expertise and authority, rather than the participants. Feminist theory enables the participants' intelligence and experiences to be honored and provides a means to question understandings of power, representation, and voice. Documentary photography is the chosen method because it allows participants to portray their social and cultural experiences as well as the community in which they reside. It also decreases power structures associated with positions of privilege in that people without the ability to read and/or write can participate along side those who can read/write.

The knowledge of the community that is co-constructed through photovoice participation portends action as photovoice projects should culminate with the participants sharing their photographs with an audience that will allow them to educate others, shed light on the issues addressed, and cultivate people's individual and collective agency to move toward social change (Wang & Burris, 1997). For instance, the 62 peasant women in the study performed a needs assessment of their community by photographing the health concerns most important to them in their home, village, or surrounding environment. Then, a slide show of the photographs was presented to local officials. The women's own words were used to describe the photographs, which conveyed the inherent value and worth of the women's voices and experiences (opposed to how women were often normally silent or absent in policy discussions). The officials listened to the women's ideas for action, and they incorporated these into new programs for educating children about health issues.

Methodology of photovoice. Three years after their seminal article, Wang and Burris (1997) published a paper describing photovoice methodology. They chose to change their original term, photo novella, because it had also been used to describe using photographs and/or pictures to teach language and literacy or tell a story. Photovoice allows participants to undertake a needs assessment or evaluation of their community through visual images while simultaneously displaying their community's assets. Yet, it goes beyond standard needs assessments "by inviting people to become advocates for their own and their community's well-being" (p. 373). Wang and Burris recommended that the first photovoice training session should address photography (how to use a camera, take photographs, etc.), ethics (when to take photos, acknowledging others, etc.), and power (who will have access to photos, who decides what is photographed, etc.). A three-stage process is utilized for participant analysis. First, participants are the ones who select the photographs. Second, participants are responsible for contextualizing their photographs and telling the stories that convey the meanings of their photographs. Third, participants aid in codifying the photographs by identifying themes and issues that emerge.

In 1998, Wang, Yi, Tao, & Caronova provided a facilitated discussion protocol, titled *SHOWeD* (words capitalized in questions below define each letter), that encouraged the three-stage process discussed above. The protocol has six questions that participants work through individually by caption writing and collectively by discussion. The first question is “What do you See here?” which is meant to be answered by someone who did not take the original photograph. Next, the participant, who took the photograph, responds to the question “What is really Happening?” and provides details beyond what she might have captured with the photograph. Then, the group discuses “How does this relate to Our lives?” in regards to the story the photograph tells. This leads the participants to contemplate “Why does this problem or strength Exist?” within their lives and community. Finally, participants determine possible action strategies by answering the question: “What can we Do about it?”

Using photovoice to address environmental concerns. Though photovoice began as a method for empowering participants in addressing health concerns and issues (Carlson, Engebretson, & Chamberlain, 2006; Catalani & Minkler, 2010; Hergenrather, Rhodes, & Bardhoshi, 2010; Strack, Magill, & Mcdonagh, 2004), it has recently been used in addressing environmental issues with youth. In 2012, Berbés-Blázquez used photovoice, as means to better understand the complex relationship between ecosystem services and human well-being in the Volcán River watershed of Costa Rica. Thirty-four residents participated in the photovoice project, and participant ages ranged from under 17 to over 55. The participants walked chosen transects throughout the watershed, which took three to four hours to complete, took photographs and discussed the ecosystem with Berbés-Blázquez. There were 11 transect walks, and group meetings were held to discuss the photographs. The *SHOWeD* protocol was used during the focus groups. The participants discussed many ecosystem services, but eight were mentioned most often and classified as priorities: "the state of waterways and creeks; the Volcán River; human-made infrastructures such as roads and bridges; pineapple plantations; sugar- cane; coffee; erosion and the mountainous landscape" (p. 868).

Photovoice enabled participants to highlight positive aspects of their environment while also exposing environmental concerns. There was no discussion as to how the photographs were displayed outside of the focus groups; therefore, the impact on policy and opportunity for social action was not addressed, which is a recommended part of photovoice projects (Wang & Burris, 1997; Wang et al., 1998).

In 2013, Beh, Bruyere, and Lolosoli evaluated photovoice as a means of helping marginalized populations living in and around areas persevered for conservation. Specifically, they worked with participants located in the remote region of Samburu East District in north-central Kenya. Twenty-six people participated in the project, and they were divided into six groups. Each group participated in four focus group sessions. At the conclusion of the project, a gallery of photographs was exhibited. The photovoice project challenged the dominant power structure, which was the absence of discussions between multiple stakeholders and struggles between conservation groups and ranchers, by encouraging and enabling multilevel discussions between youths, park rangers, teachers, and ranchers, and these discussions produced a locally relevant knowledge base regarding local conservation concerns. The participants selected the seven themes (deforestation, human pollution, wildlife, carcasses, culture and spirituality, and community, and the way forward) for the final gallery that identified their environmental concerns, and they provided action ideas for addressing their concerns.

In a similar study, Bennett and Dearden (2013) used photovoice as part of a larger study focused on the adaptive nature of two communities on the Andaman Coast of Thailand. The two photovoice sessions allowed the researchers and participants to explore the perceived changes to both the natural environment and social communities along the coast. Twenty-three people participated and their ages ranged from 20-60+. The researchers modified the photovoice process by conducting individual interviews instead of focus groups. Several common environmental themes were portrayed in the photographs and narratives such as decline in marine life, increase in island erosion, impacts of tourism, and community decisions involving conservation areas. There were also social themes that emerged such as increased employment in tourism, increased technology, and impacts of migration and population growth. There were also underlying themes in the participants' narratives used to describe their photographs; these included feelings of powerlessness to address issues and discussion of resistance to and adaptions to local changes. Though books were chosen by the participants as the means to display the photographs, the authors do not discuss how these books were distributed or to whom they were given, which questions how effective these particular projects were in regards to giving participants opportunities to engage in social action.

Photovoice in science education and EE. Photovoice is also beginning to be used in science and environmental education settings. Cook and Quigley (2013) used photovoice in their non-majors science classes to encourage students to engage in authentic scientific inquiry and explore environmental issues on campus. Though the two classes were conducted at two different universities, both projects were semester long and aided students (n= 24 and n= 13) in the development of a semester-long scientific inquiry project. Whole class discussion was the unit analysis, and the *SHOWeD* protocol was utilized to promote class discussion of the photographs. Students also attended a local community event that encouraged dialogue around issues of sustainability; thus, students had the opportunity to engage in discussion with informed community members about their photos. Three overarching themes emerged: "(1) photovoice connected students to the science in their place, (2) photovoice provided the connection to authentic scientific inquiry, and (3) photovoice empowered students to dialogue with informed community members" (p. 347). Similar to Berbés-Blázquez (2012) and Bennett and Dearden (2013), Cook and Quigley do not discuss how their use of photovoice allowed students to engage in social action; yet, they do demonstrate how photovoice can be used in science classrooms.

As the above studies illustrate, there is little evidence of social action when photovoice is used in EE. This has been discussed by other scholars (Catalani & Minkler, 2010) as one of the most difficult aspects of photovoice. The time investment for enacting societal change is often a limiting factor in photovoice studies as securing participants for multiple years can be challenging. Also, securing funds for multiple phases of a project can limit the amount of social action that occurs, and as Wang et al. (1998) attest sometimes the political and cultural norms of a society limit the impact participatory research can have. However, Wang et al. attest that even if the overall societal impact is low, the benefits for participants can still be great and open up dialogues between groups that were once uncommunicative.

Purpose of photovoice in Academy HRE. The studies discussed above are evidence of how photovoice can be used to address environmental issues and provide evidence for why photovoice is a methodology that should be explored in EE. Thus, with its emphasis on community and social involvement, which directly supports the mission of The Academy, and its recent use in EE, photovoice was selected for use in the herpetology class. Photovoice was altered for The Academy HRE in that students focused on how herps are being affected in their local communities and what this in turn means for the natural environment and community. The students were asked to speak from the perspective of the organism as well as from their own perspective. Students became advocates for a group of organisms that many find repulsive (Bixler & Floyd, 2010), and they enacted change by educating their families, friends, and community with their stories and photos.

Academy HRE photovoice project. Two days into the course, Dr. T introduced participants to photovoice through a Haitian photo project, *Frame of Mind Haiti*, sponsored by Frame of Mind, Conservation International, and Panos Caribbean. A group of youths from Jacmel, Haiti participated in two week-long workshops from August 2011 to February 2012. By combining conservation education and photography, the participants created photo stories about their relationships with their natural and cultural environments. The results of their work were complied into a book, which served as Dr. T's introduction to the HRE photovoice project. Dr. T passed out sections of the book to small groups of scholars, and the groups exchanged the sections until each group had seen each section. The groups were instructed to examine the sections and determine what the Haitian youth were hoping to convey with their photographs. This example was used to demonstrate to the scholars that photographs could be used to highlight environmental issues faced by communities and that it did not require a professional photographer or an adult to produce meaningful photos.

Next, I used a photograph (Figure 2) from a past HRE to engage the class in a conversation about the photograph. As I displayed the photograph for the students, I asked them the first question (What do you see?) from the photovoice protocol Dr. T and I adapted (see Appendix A). Participants' answers focused on the trash (Sunny D bottle), the hand, wire, and a trapped animal. Then, I explained to them what was really happening in the photograph (second question in modified protocol; see Appendix A) by showing the photograph of an aquatic turtle trap in Figure 3 and describing how the trap works and how the Sunny D bottle helped to keep the trap afloat.

Figure 2. Photograph Used in Photovoice Example.

Figure 3. Photograph Used to Explain Photovoice Example.

To further clarify why I chose a close-up photograph of the trap, I explained to the students how focusing in or zooming in on the trap allowed me to control what my audience was able to see; thus, as photographers, we frame what is visible and we decide how to frame the photograph to focus people's attention. The discussion continued by me asking the participants how the photograph related to them, their community, or herps (third question in modified protocol; see Appendix A). Participants' responses centered on how research was being conducted which provided more information about aquatic turtles. For the fourth protocol question (why does this situation, condition, or strength exist; see Appendix A), students again discussed how the traps were needed for research.

Next, we discussed how the image could be used to educate others (fifth question of modified protocol; see Appendix A). Participants' recognized that if they did not know what aquatic turtle traps were then most people in the community would not either. To elaborate on their insight, I shared a story with the students based on an experience a colleague of mine had when she attempted to conduct an aquatic turtle investigation on her college campus. Students at the college saw the traps and thought someone was hurting the turtles. They called the campus security, which came and destroyed all the traps in order to free the turtles. One participant (Betty) also pointed out how this related to my colleague's life and how as beginning herpetologists it related to the participants' lives (question three on modified protocol; see Appendix A). We ended the example with contemplating what my colleague could do about the situation (question six on modified protocol; see Appendix A). Ideas generated included making posters that described the aquatic turtle trap and why it was used, instagramming the photograph, and contacting the campus public relations office to run a story on the investigation. My presentation concluded with three questions participants were to ask themselves when they took a photograph for the photovoice project: (1) What is my purpose?; (2) Who is my audience?; and (3) What is my call to action?

After my example, students learned from Dr. T that they were going to begin to take photographs for a photovoice project that they would work on periodically during the year to present at community wide events in the spring. Students were told that the purpose of the project was to educate people about their communities, environment, and herps (amphibians and reptiles). The focus on amphibians and reptiles was one way Dr. T and I modified photovoice for her course. We decided that scholars could do a community needs assessment not only from their perspective but also from the herps' perspective given that the course focused on herpetology and herp populations are declining globally. This modification was purposefully done as we desired to bring an ecojustice focus to the course, which "enlarges social justice to ecological well-being, environmental issues, and recognition of the significance of preserving the cultural and environmental commons and the role that it plays in maintaining the ecological integrity of the Earth" (Mitchell & Mueller, 2010, p. 209).

To help them begin their journey, scholars were given photo prompts to guide them as they went home the first weekend after beginning the HRE (see Appendix B). Participants were provided with digital cameras that were borrowed from a local university. Before the participants took the cameras home I provided instruction on how to use the camera, and participants were given class time (~30 minutes) to practice using the camera. This ensured participants could ask for help with using the camera, and they quickly began helping each other as they became more acquainted with the technology. The cameras were originally going to be distributed on Fridays when scholars went home for the weekend. However, the scholars soon began asking for their cameras when animals were brought into the class or when we went on field investigations. Keeping with the organic nature of photovoice, we decided that the students could keep their cameras throughout the week, as we realized scholars defined the university campus as part of their community; therefore, participants were engaged in taking photographs for their photovoice projects throughout the four-week summer program. Once a week, photographs were uploaded to class laptops and a community flash drive. Since the photovoice project was a class project (see), all scholars engaged in the project. Data were collected only from participants who consented to participate in this study (N = 19 and n = 16).

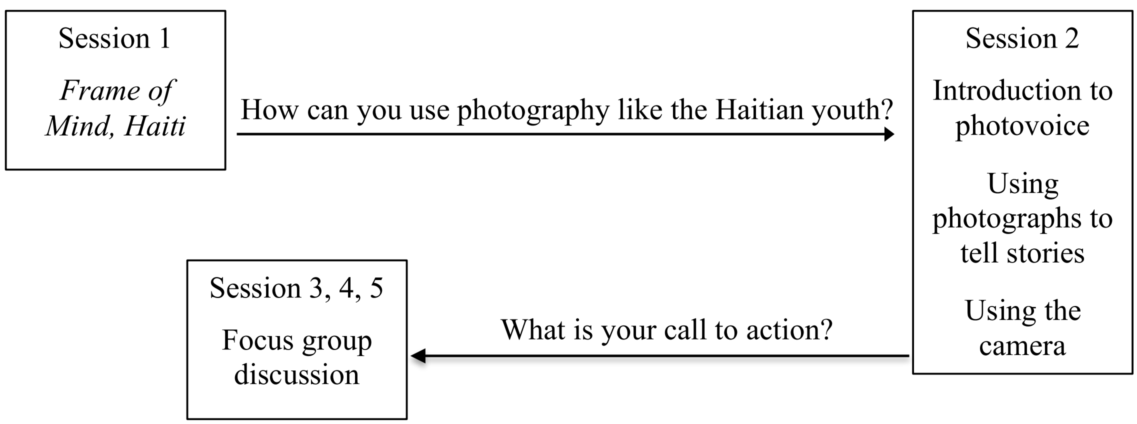

Figure 4. Photovoice Schematic for Academy HRE. Adapted from (Beh et al., 2013).

At the conclusion of the summer Academy HRE, youth had participated in three focus group discussions on their photovoice projects and were beginning to select the photograph or photographs they would highlight in the poster they would be designing during the academic year. All participants were given compact discs with their photographs, so they would have their photographs to take home with them. Participants were also given hardcopies of their three favorite photographs.

My involvement in the Academy HRE. During the 2013 summer Academy HRE, I assisted Dr. T throughout the course. I co-planned the photovoice project with her, and I served as the technological expert for the project. I assisted scholars in the handling of live animals, answered questions about the class material, and helped them select and upload their photographs. I taught two class sessions during the HRE, one introducing the scholars to photovoice and one on lizards. I was an active member of the community, and I attended all of the summer HRE activities.

Participant Selection

Since the site selection for my proposed study was purposeful, the participant selection was also purposeful. As in case study sampling, purposeful participant selections "are selected deliberately to provide information that is particularly relevant to your questions and goals, and that can't be gotten as well from other choices" (Maxwell, 2013, p. 97). Teddlie and Yu (2007) describe this as sampling special or unique cases that become "a major focus of the investigation (rather than an issue)" (p. 80). Though some scholars might question whether purposeful sampling affected the validity of my study due to a biased selection, Patton (2002) argues,

> The sample was purposefully 'biased,' not to make the program look good, but rather to learn from those who were exemplars of good practice. In many instances, more can be learned from intensively studying exemplary information-rich cases than can be learned from statistical depictions of what the average is like. (p. 233)

Participants

I purposefully decided to study the Academy HRE because I knew that my research participants would be diverse youth, given the mission of the Academy. These youth willingly chose to be involved in the Academy HRE, as students in the Academy were able to choose their summer courses. The youths' self-selecting to be part of the Academy HRE coupled with the academy's high academic expectations suggested that most students would be active participants in the Academy HRE. This had important implications for my study as my research questions were designed to investigate youth, who were actively participating in the Academy HRE. By focusing on an exemplar group of participants, I was able to collect data that attended to my conceptual framework (Creswell, 2012; Maxwell, 2013; Patton, 2002; Teddlie & Yu, 2007).

Of the 19 participants, I was able to obtain full IRB consent for 16 of the 19 participants. One participant chose not to participate in the study, and the other two participants were international students and obtaining parental consent was not possible. The demographics of my 16 participants are listed in Table 2. Participants provided their ethnicity and residence (rural, suburban, urban) on the first day of the course as part of the pre-survey (see Appendix C). Though my participants are from diverse backgrounds and represent underserved populations in higher education per the Academy's focus, it should be noted that the students are selected for the Academy based on academic promise, no evidence of school disciplinary issues, demonstration of financial need, and limited family history of college attendance.

Table 2

Participant Demographics

Ethnicity	**Academy HRE**[a]
African American	6
Biracial	3
Caucasian	6
Hispanic	1
Gender	
Females	9
Males	7
Grade[b]	
10	5
11	8
12	3
Residence	
Rural	4
Suburban	3
Urban	9

Note. [a]n =16. [b]Grade refers to the participants' rising grade level for the 2013-2014 school year.

Thus, the sample is not as heterogeneous as it might first appear. The students are alike in that they are from similar low socioeconomic income families and perform relatively well in school, though as indicated by the students' grades (see Table 3) this does not equate to all students having an A average. However, the students (known as scholars) competed for acceptance into the Academy, and once accepted, they are expected to follow all the guidelines of the Academy. This includes attending a month-long residential program during three consecutive summers preceding their sophomore, junior, and seniors years. Scholars must also attend a monthly Saturday program during the three years that they are a part of the Academy; hence, there is a substantial time commitment on the part of the students.

Table 3

Individual Participant Demographics

Participant[a]	Grade[b]	Ethnicity	Gender	Residence	Grades[c]	Science ability/ interest score[d]
Andy	10	AA/C	Male	Urban	A's, B's, & C's	4.8
Gary	10	AA/C	Male	Urban	A's & B's	4.0
Jaylyn	10	AA	Male	Urban	A's	4.2
Kadence	10	AA	Female	Urban	A's	3.8
Alicia	11	H	Female	Urban	A's	4.2
Betty	11	C	Female	Rural	A's	5.0
Elaine	11	AA	Female	Urban	A's & B's	2.8
Jasmine	11	C	Female	Suburban	A's	3.6
Kimberly	11	C	Female	Rural	A's	3.4
Mary	11	C	Female	Urban	A's	3.6
Patrick	11	AA	Male	Suburban	A's	4.0
Quincy	11	AA	Male	Urban	A's & B's	3.4
Tabitha	11	AA/C	Female	Rural	A's & B's	3.0
Barbara	12	C	Female	Urban	A's	5.0
Casey	12	C	Male	Rural	B's	5.0
Kamal	12	AA	Male	Suburban	B's & C's	3.4

Note. AA = African American; AA/C = African American/Caucasian; C = Caucasian; H = Hispanic. Bolded names were second year participants (SRAs).
[a]Psuedoynms used. Participants are grouped alphabetically by grade. [b]Rising grade level for the 2013-2014 school year. [c]Self-reported grades for the 2012-2013 school year. [d]Obtained by averaging pre-survey questions 38, 39, 40, 48, and 54. Likert scale rating of 1 (not at all) to 5 (very likely).

Given the ethnographic nature of my study and the emphasis on qualitative methodology, it is important to provide detailed descriptions of my participants. Thus, in the following sections, I describe each of my participants (see Table 3 for overview of participants by grade level; see Table 4 for class grouping), as they entered the Academy HRE program.

Table 4

Class Table Groupings

Group number	Group members
1	**Barbara**, **Casey**, Kamal, Kadence, Mary, International student
2	Alicia, Betty, Elaine, Jaylyn
3	Patrick, Quincy, International student, Additional non-participant
4	Andy, Gary, Jasmine, Kimberly, Tabitha

Note. The group number was assigned by me in order to aid field note taking while in the classroom. The students were allowed to select their seats on the first day of class. The stools were grouped around lab tables. Though Dr. T never told them to continue sitting at the same table, all participants remained at the same tables throughout the course. Bolded names were second year participants (SRAs).

The Sophomores

Andy. Andy, of African American and Caucasian heritage, lived in an urban area. His grades for the 2012-2013 school year were a mix of A’s, B’s, and C’s. To fulfill his freshman math and science requirements, he completed two honors courses —geometry and biology, receiving a C and B, respectively, as his final course grades (pre-survey data).

Andy, one of seven males in the Academy HRE, selected this course due to his strong interest in science and his exceptionally strong belief in his own science abilities (4.8). An active participant in the class and the field experiences (often volunteering to both answer questions and hold animals), Andy was comfortable with herps and often facilitated, along with Kimberly, the learning of others in group 4 (see Table 4; field note data).

Gary. Like Andy, Gary lived in an urban area and self identified as an African American/Caucasian male. His final ninth course grades were mostly A's and B's. His math and science classes were not honors level, but he did complete algebra I, with a B, and earth and environmental science with a C (pre-survey data).

Gary did not provide a reason for selecting the Academy HRE, but he did exhibit a high view of his own science abilities (4.0). Gary rarely volunteered questions or answers in the large group but was an active participant in his small group. He often asked questions of Dr. T when she approached his group, and he was the group member who most often referred to his field guide when the group worked with herps. During field investigations, Gary was a supportive partner but did not assert himself as a group leader (field note data).

Jaylyn. Jaylyn, an American African male, also resided in an urban area; however, prior to moving to the city, he had lived in rural environments (pre-survey and exit interview data). Jaylyn's final ninth course grades were mostly A's. He, like Andy, elected to take honors math (geometry) and science (biology) courses, receiving an A in both courses (pre-survey data).

Jaylyn chose the Academy HRE due to his great love for science and animals and his strong belief in his own science abilities (4.2). Not one to shy away from asking questions, Jaylyn and his group partner, Betty, were the two participants who asked the most questions during large group time. Though Jaylyn was very curious, he did not embrace holding the animals, rather he was often seen observing Betty holding the organisms. Jaylyn often watched as others looked for herps during the field investigations, though he always joined the group once an organism was found and discussions commenced about how to identify it (field note data).

Kadence. Residing in an urban area, Kadence, one of the nine female participants, was of African American heritage. Her freshman year of high school ended with her making A's in most of her classes. For her math and science requirements, Kadence took algebra II and earth and environmental science, and she received an A in both courses (pre-survey data).

Her love for turtles guided her selection of the Academy HRE. She had always wanted to have a turtle for a pet, and she hoped this course would teach her how to better take care of them. Kadence shared this love of turtles with Alicia, though they were not in the same small group (see Table 4). Though Kadence rated her science abilities as a little above average (3.8), she was an enthusiastic participant in the classroom and often volunteered to share stories with the class, and she entertained her small group with various stories throughout the course. Kadence was more subdued during field investigations, as she adjusted to the various types of herps that could be encountered.

Yet, she did not shy away from holding the organisms even if she was at first apprehensive (field note data).

The Juniors

Alicia. Like Kadence, Alicia also resided in an urban area. However, she was the only participant of Latina heritage. In school, Alicia's sophomore grades were mostly A's, including A's in algebra II and chemistry (pre-survey data).

Alicia shared Kadence's love of turtles, but her reasons for taking the course were broader in that she desired to spend time in nature, learn more about herps in general, and conquer her fear of snakes. Though she had a very positive view of her science abilities, rating them at a 4.2, she, at first, was quiet in the classroom. As the course progressed, Alicia asked more questions and became a leader in group 2 (see Table 4), encouraging her classmates to touch the organisms. She often elicited help from the instructors if she was uncertain about how to handle an organism. In the field, Alicia was eager to explore and was not afraid to venture off by herself looking for rocks and logs to turn over and explore underneath. She was at times hesitant to pick up organisms she found, but this was mostly due to her concern that she could hurt the animal (field note data).

Betty. Betty, one of four participants who resided in a rural area, was a Caucasian female. Her grades for the 2012-2013 school year consisted of mostly A's. She took two math classes (algebra II and geometry) and two science classes (earth and environmental science and biology), and she received two B's and two A's, respectively in these classes (pre-survey data).

Betty was extremely confident in her science abilities (5.0). Her strong belief in herself, combined with her love of science and creatures, especially snakes and spiders, contributed to her selection of the Academy HRE as an elective course. Never one to shy away from participating, Betty contributed answers and asked questions at least three times or more during each class session. Even when her answer was incorrect, Betty did not hesitate in answering the next question presented to the class. Betty was often the leader in group 2 (see Table 4), especially when it came to holding animals. She could often be heard telling other participants how to hold the various animals. In the field, Betty was slightly more subdued, seeming to tire easily, but she was an active participant once an organism was spotted and would insist on holding the find (field note data).

Elaine. Like Alicia, Elaine, an African American female, lived in an urban area. She received mostly A's and B's in school, and she got B's in honors math (geometry) and honors science (biology) in her sophomore year (pre-survey data).

Though Elaine was successful in her honors biology class, she had a low view of her science abilities, as indicated on her pre-survey with a 2.8, which was the lowest score among the 16 participants. She was the only participant to rate herself at the lowest end of the scale for *I think I would be a good scientist*. She chose to take the herpetology course due to her interest in snakes and frogs. Elaine was extremely quiet during the course and on the field investigations. Yet, she would ask questions of her group members and did attempt to handle most organisms after her classmates encouraged her to do so. She also actively used her field guide and participated in animal identification both in the field and in the classroom (field note data).

Jasmine. Jasmine, one of five Caucasian females, resided in a suburban area and obtained mostly A's in her high school classes. She received an A in both her algebra II and biology class (pre-survey data).

Jasmine selected the herpetology course in order to learn more about science, and she had a moderate view of her science abilities (3.6). Jasmine did not volunteer much in class, but she did respond to Andy's and Kimberly's encouragement to touch and hold organisms. She also helped Tabitha become comfortable with the organisms both in the class and in the field. During field investigations, Jasmine was a team player and worked with whoever was near to check traps or lift logs to find animals (field survey data).

Kimberly. Like Jasmine, Kimberly was a Caucasian female, but she was one of four participants who lived in a rural area. During the 2012-2013 school year, she received mostly A's. She elected to take two math courses, algebra II and AP statistics, and obtained A's in both. For her sophomore science credit, she took chemistry, where she also earned an A for the course (pre-survey data).

Similar to Kadence and Jasmine, Kimberly had a moderate view of her science abilities (3.4). However, she was the only participant to give herself the lowest level for *I am good at science*. Kimberly elected to be part of the Academy HRE because she had heard from others that the course was fun and she had a love of animals. Kimberly's participation in the course increased throughout the four weeks. At first, she did not volunteer information and would only occasionally ask questions that she had. By the end of the course, Kimberly enthusiastically asked questions and actively participated in class discussions. Serving as a leader in group 4 (see Table 4), Kimberly was comfortable with the organisms and Dr. T often handed her an organism first once the class had been instructed on proper handling techniques. Kimberly also led in the field and was not afraid to capture any organism the group found.

Mary. Mary was a Caucasian female, who lived in a predominately urban area of the county. Her school grades consisted of mostly A's, and she made an A in both honors algebra II and honors biology courses (pre-survey data).

Similar to Kimberly, Mary selected the course because of how much others had told her they had enjoyed it. Mary also believed herself to be average in her science abilities (3.6). In class, Mary participated in her small group but not as much in the larger whole group. She was often timid with the organisms and would hold or touch them only after Kimberly had done so, even though Kimberly was not at her official class table. In the field, Mary waited on others to decide what traps or logs to check, as she observed the flowers and trees. She was often on the outside of the circle when organisms were being presented to the group. However, before the organism was placed back where it had been found, she made sure that she had an opportunity to see and touch it, and sometimes she insisted on holding it, particularly if it was a frog (field note data).

Patrick. Patrick was an African American male and lived in a suburban area. In school, he received mostly A's in his courses. For his math and science requirements, he took pre-calculus and chemistry, and he achieved an A and B, respectively (pre-survey data).

Patrick had participated in the herpetology elective offered during the 2012-2013 school year. He chose the Academy HRE due to his interest in nature, and he had a high view of his science abilities (4.0). Patrick was encouraged by Dr. T to share his previous experiences with the class, and he often lead his group when they worked with organisms. However, he was quiet during whole class discussions and often waited to ask questions until Dr. T came around to the groups. In the field, Patrick asked the most habitat related questions, and he often took time to simply stand in the forest and look around him before beginning to search for herps (field note data).

Quincy. One of four African American male participants, Quincy lived in an urban area. In school, he made mostly A's and B's. In his sophomore math class (algebra II), he received a B, while he obtained a C in his biology class (pre-survey data).

Quincy, like Patrick, had participated in the herpetology elective that was offered as part of the Academy's 2012-2013 school year program. In this elective, also taught by Dr. T, the class met together once a month for 90 minutes. Quincy enjoyed his time in the herpetology elective, and this influenced his selection of the summer herpetology course. He rated his science abilities as average (3.4). Though Quincy had prior experience, he did not readily assert himself as an expert. However, Dr. T often asked him to share his experiences and his knowledge of herps. Quincy was an active member of group 3 (see Table 4), and he was attentive and inquisitive during field investigations (field note data).

Tabitha. Growing up in a rural area, Tabitha self identified as an African American/Caucasian female. During her sophomore year of high school, her grades were composed of mostly A's and B's, and she received a B in geometry and an A in biology (pre-survey data).

Influenced by past participants' stories of the Academy HRE, Tabitha, like Kimberly and Mary, signed up for the course based on how much fun previous participants said the course was. She viewed her science abilities as average, rating herself a 3.0. During the course, Tabitha was attentive but rarely spoke during large group instruction. She did interact with her group and would touch and hold organisms when encouraged by group 4 (see Table 4). In the field, Tabitha helped classmates look for herps, but she did not venture out by herself, preferring to stay close to others (field note data).

The Seniors

Barbara. Barbara, a Caucasian female, lived in a primarily urban area. In her junior year of high school, she received mostly A's. Though she did not take a math class, she took three science classes (forensic science, genetics & biotechnology, and marine science) and achieved an A in each course (pre-survey data).

Barbara was one of the two student research assistants (SRAs) for the course. She attended the Academy HRE the previous summer and desired to take the course again because she enjoyed the first summer and felt she still had more to learn. She was very confident in her science abilities and was one of three participants who rated themselves a 5.0 (the highest score possible). Barbara fully embraced her SRA role, as she walked around the classroom and helped other students as they worked with animals. Barbara also took on leadership roles in the field investigations and was often put in charge of larger groups by Dr. T (field note data).

Casey. The other SRA for the course, Casey, was a Caucasian male, who lived in a predominately rural area. His grades for the 2012-2013 school year were mostly B’s. For his math credit, he took pre-calculus and received a B. For science, he elected honors biology II and achieved a B (pre-survey data).

Casey, like Barbara, elected to take the Academy HRE for a second time to increase his knowledge of herpetology. He also had a high view of his science abilities (5.0). Casey was not as active as Barbara during the herpetology course. He helped others when prompted by Dr. T, but he did not take the initiative himself as Barbara did. However, he often led groups in the field, and he even got permission from his mom to invite the class to his house to conduct a herp bioblitz (a survey of the property for any type of herp) (field note data).

Kamal. Kamal, an African American male, resided in a suburban area. In school, his grades consisted of mostly B’s and C’s. He took two math courses, algebra II and pre-calculus, and one science course, chemistry, and he received a C in all three courses.

Kamal did not give a definitive reason for taking the Academy HRE, and he had a moderate view of his science abilities (3.4). Kamal’s participation in the course was consistent from beginning to end. He asked questions, answered questions, helped his group, and was interested in most of the organisms. His one big fear was frogs, and he did not care that much for salamanders, though he did have a pet snake. Kamal was also an active participant in the field and often helped others when in the forest by holding branches or telling people where holes in the ground were located (field note data).

Methods of Data Collection

My largely qualitative research study, an ethnography of the Academy HRE, was conducted over a month in the summer of 2013. During this time, I immersed myself in the HRE as an active participant observer, which Spradley (1980) described as seeking "to do what other people do." By doing so, I was able to develop a thick, rich description of what participants did and experienced in the HRE, and I believe that I was able to better understand the meanings participants made of the HRE (Glesne, 2011). I observed all but two summer sessions because I taught these two sessions. Another educational researcher, who was part of the larger HERP Project research team, observed and recorded these two sessions for me.

During the HRE sessions, I was an active participant observer as this enabled me to "learn firsthand how the actions of research participants corresponded to their words; see patterns; experience the unexpected as well as the expected; and develop a quality of trust, relationship, and obligation with others in the setting" (Glesne, 2011, p. 63). More specifically, I was an active participant observer because I assisted with technology implementation in the HRE and in the fieldwork due to my prior experience as a field ecologist and science educator (Schram, 2006; Spradley, 1980). I also taught a summer session on photovoice and one on lizards and assisted with development of the photovoice project. Data were collected through descriptive and reflective observations and field notes (Creswell, 2012), semi-structured individual interviews, photovoice focus group interviews, photovoice assignments and projects, pre/post-surveys, and pre/post-tests.

Observations and Field Notes

Observations and field notes were gathered using a structured observation protocol (see Appendix D). The observation protocol was developed using Spradley's (1980) descriptive question matrix. My observations centered on what the students were doing, saying, and producing during the classroom activities, field experiences, and photovoice focus groups. Observations were recorded throughout the HRE sessions, and as Spradley recommends, I attempted to record as much of "a verbatim? record of what participants said" as possible (p. 67). I processed my observations into expanded field notes within twenty-four hours of each observation as suggested by Miles and Huberman (2014) and Spradley. Other educational researchers who assisted me when I was teaching also used this observation protocol.

Semi-structured Interviews

Individual participant interviews were conducted at the conclusion of the summer HRE (see Appendix E). As there was limited time to complete the interviews, members from The HERP Project research team assisted me with the summer HRE interviews. The larger research team (primarily Dr. Carlone) developed the summer interview protocol, and I added questions specific to my study. The interview protocol was organized into three parts. The first part had two questions designed to better understand how participants described themselves in regards to their experiences in the HRE. Part two consisted of four questions that were designed to elicit youths' stories in order to afford the students opportunities to discuss their experiences and their meanings of those experiences. The third part had seven questions, which asked students about specific experiences during the HRE. There were three additional questions at the end for interviewers to ask if there was time remaining. Most interviews lasted 30 to 45 minutes and were audio recorded.

Photovoice Focus Groups

During the Academy HRE, three photovoice focus group interviews were conducted. Dr. T, Bryan (the teaching assistant), Aerin (a fellow doctoral student on The HERP Project), and I conducted the focus group interviews. Students were grouped heterogeneously by grade level and gender, and similar groups were used each time, which helped me to place students, who had not given consent to be part of the study, into Bryan's group. Due to needing time to work on their documentary film, Barbara and Casey only participated in the first photovoice focus group.

I videotaped and transcribed each photovoice focus group interview, and I reviewed these prior to the next week's photovoice assignment as it helped Dr. T and me understand how the students were responding to and understanding the photovoice project, which also informed the ongoing decisions we made about the implementation of the photovoice project.

The photovoice focus group protocol was adapted from the *SHOWeD* protocol that multiple photovoice researchers have used (Strack et al., 2004; Wang & Burris, 1994, 1997). The protocol was slightly modified to better fit our specific project (Appendix F). In question three of the protocol, we added a focus on herps, so scholars had opportunities to reflect on and discuss how the photographs related to amphibians and reptiles. The purpose of the photovoice focus group was two-fold: (1) To help the students develop their projects and have group discussions concerning the environment, herps, and their communities; and (2) To obtain data to answer my research questions.

At the beginning of the focus group, a participant shared her favorite photograph with her group and asked the group, “What do you see?” After the group members shared what they saw, the youth presenting answered question two (What is really happening?). She also presented a possible caption for her photograph, and the group members commented on the caption and/or asked her questions. All scholars were encouraged to answer the remaining four questions. Facilitators (Dr. T, Aerin, Bryan, and me) were instructed to try not to engage in the discussion but to allow the group members to freely discuss with each other; however, if one or two scholars were doing the majority of the talking, facilitators did negotiate time and space for scholars who were not able to contribute as much. Focus groups lasted between 25-30 minutes, and each focus group was conducted at the same time but in separate locations.

Photovoice Assignments

Photovoice assignments during the summer HRE were collected as additional data sources. These assignments included photographs, participant photo selection preferences, and practice with writing captions.

Pre/post-tests and Pre/post-surveys

As part of the larger HERP Project educational research, pre/post-tests (see Appendix G) and pre/post-surveys (see Appendices C and H) were administered. Though I did not design these instruments, they served to provide additional data to support the qualitative data I collected. They also allowed me to quantify the students’ understanding of herpetology, the time they spent in the outdoors prior to the program, their attitudes toward and interests in science, and their overall satisfaction with various aspects of the program. One participant, Andy, left class early on the final day and was unable to complete the post-survey.

The data collection methods, described above, and the data analysis methods, discussed in the next section, enabled me to address each of my research questions (see Appendix I). Additionally, collecting and analyzing multiple sources of data provided triangulation (validating findings with two or methods) and crystallization (use of multiple methods to provide more in-depth understanding of complex issues (Tracy, 2010) in my research study. I will discuss this in more detail when I address potential validity and ethical concerns regarding my research.

Methods of Data Analysis

Qualitative Data Analysis

As recommended by Maxwell (2013) and Miles and Huberman (2014), data collection and preliminary data analysis were simultaneous, which aided in collecting more robust and informed data. After the data collection was completed, all audio/video recordings and written notes of interviews, observations (field notes), and photovoice focus groups were transcribed, providing text for data analysis. Multiple steps were taken to determine the salient themes that emerged for each research question. Thus, data analysis was an iterative process as I combed data for emergent patterns related to the meanings participants were making of the experience (Tracy, 2013).

I conducted my qualitative data analysis using Dedoose, a mixed methods software program that allows for coding of text, videos, and photographs. As Silver and Lewins (2014) attest, "Dedoose is a well-developed code-based system which can be manipulated for a range of methodologies" (p. 101). This software allowed me to visualize my data through the uses of its various charts and graphs, which helped me to readily identify patterns within my codes. Dedoose enabled me to conduct multiple forms of analyses, including data coding, grouping and nesting of codes, and frequency count calculations, which increased the rigor of my analysis.

My first step was to conduct an overall analysis of the student interviews and photovoice focus groups, looking for evidence to answer research question one (leveraging youths' experiences) and two (enabling CEA). I used coding categories that emerged from the theoretical propositions related to my conceptual framework of CEA. Thus, my coding category for research question one included instances where youths' experiences were leveraged. For research question two, I had five coding categories, which correlated to the principles of CEA (instances where learning occurred, expertise was demonstrated/discussed, place was important, environmental issues were discussed, transformations in self or environmental views)

Next, I used Spradley's (1980) data analysis methods for ethnography and analyzed each instance for emergent patterns of participant meaning. These emergent patterns became my initial codes as I continued to search and uncover the meanings participants made and how they conveyed these meanings to others (Leech & Onwuegbuzie, 2007). I used invivo coding (a term which means using students' own words, which are always in quotes, so that students' words actually became codes) whenever possible to help me better identify my codes as well as similarities and differences among participants (Creswell, 2012; Miles & Huberman, 2014). During this second stage of analyses, I realized I needed a separate category for CEA, as several initial codes were characteristic of all five principles.

After uncovering the initial codes, I collapsed similar codes into thematic units (Miles & Huberman, 2014). The resulting salient themes were triangulated with data from observations and field notes and photovoice assignments; this process also allowed me to further refine my themes.

Once I had established my themes for research questions one and two, I performed a third round of data analysis specifically searching for points of contrast and/or contradiction to my themes (Spradley, 1980), which were grouped together to form my research question three coding category (constraining CEA). Next, I went through the same process as I had for research questions one and two looking for emergent patterns, which developed into my initial codes. Finally, I sorted and grouped my initial codes, which led to the emergence of the salient themes for research question three.

Quantitative Data Analysis

For my analysis of the pre/post-tests, I ran a Wilcoxon signed-rank test on the pre/post-test scores to determine significance of collective gain scores. Then, I examined individual students' pre-test and post-test scores to determine how many points they had gained on the post-tests. Next, I analyzed the collective gain scores to examine ethnicity (Caucasian, non-Caucasian), grades (A's and non-A's), and gender (female, male).

I used the pre/post-survey questions to develop a self-reported science ability and interest score, which was accomplished by averaging pre-survey questions 38, 39, 40, 48, and 54 and post-survey questions 1-5, for each individual. After the scores were calculated, I ran a Wilcoxon signed-rank test to determine significance. Like the pre/post-test analysis, I analyzed the gain scores to determine if there was a significant difference between ethnicity, grades, and gender. I used Statistical Program for Social Sciences (SPSS) 22 to conduct my quantitative analyses.

It needs to be acknowledged that my sample size is small ($n = 16$), so there were limitations on the types of statistical measures I could run. I used non-parametric statistics due to my small sample size and the positively skewed data. This also forced me to collapse ethnicity and grades into two categories each instead of running an analysis on the four ethnic groups and the four groups for school grades. I was unable to run tests to compare grade level in school (e.g. sophomore) and residence (e.g. rural) as the groups were too small and could not readily be collapsed into larger categories. Given that I am not attempting to generalize my findings to a larger population, the quantitative data analyses do provide further support of my findings.

Mixed Methods Analysis

Finally, I coded the post-survey questions for prominent descriptors for each individual principle of CEA. I calculated class averages and examined individual student responses. Next, I calculated individual averages for each individual principle of CEA, ran Wilcoxon rank-sum test and analyzed the averages to determine if there was a significant difference between ethnicity, gender, and grades. After the quantitative analyses were complete, I used Dedoose to run frequency counts to determine if there were any significance differences in the qualitative data for ethnicity, gain scores on post-survey and post-test, gender, grades, and principle and CEA averages. Multiple forms of data and analyses increased the validity of my study, which I discuss in the next section of this chapter.

Validity

Maxwell (2013) defines validity as "the correctness or credibility of a description, conclusion, explanation, interpretation or other sort of account" (p. 122), though he is quick to remind his readers that validity is a goal as opposed to a product. Patton (2002) further asserts that the quality and creditability of a study depends upon the criteria used, the audience addressed, and the research paradigm of the study. In her discussion of validity criteria, Tracy (2010) agrees with Patton's assertion when she states "each criterion of quality can be approached via a variety of paths and crafts, the combination of which depends on the specific researcher, context, theoretical affiliation, and project" (p. 837). Thus, I identified two specific validity threats (researcher subjectivity and reactivity) that could lead to invalid findings in my research, and I have outlined the ways I addressed these threats.

Researcher Subjectivity

I believe that exposing youth to field ecology and herpetology will increase the likelihood of them engaging in science. This personal belief could pose a threat to the validity of my study if I only collected data from my participants that supported my personal beliefs. To guard against this, I collected data from all participants regardless of their environmental beliefs. Maxwell (2013) and Patton (2002) recommend searching for discrepant evidence and negative cases, which I implemented in my data analysis. Thus, I searched for cases that disproved my initial findings. In addition, my long-term involvement in the HRE (I served as the assistant director for another HRE (2012-2014), was the lizard project leader at the third HRE (2012-2014), and helped collect data during the 2012 Academy HRE), repeated observations, and multiple interviews provided me with rich data that were detailed and varied enough to provide a thick, rich description of the HRE and participants (Maxwell, 2013; Merriam, 2000; Patton, 2002; Tracy, 2013).

I also performed member checks with Dr. T and Aerin (fellow doctoral student on the HERP Project) to assess the quality of my interpretations in regards to the participants' meanings and perspectives (Creswell, 2012; Maxwell, 2013; Patton, 2002. Dr. T was able to provide an insider's perspective, while Aerin provided an educational researcher's perspective. Additionally, the member checks, multiple data sources, and methods aided in the crystallization of my study. Crystallization encourages researchers to gather data from multiple sources and apply various methods in order to uncover a more complex, in-depth understanding of the issue. Unlike triangulation, which uses various data sources to confirm research results and thus is more positivistic in nature, crystallization assumes gathering data from multiple sources and applying various methods allows the researcher to develop more robust findings (Tracy, 2010). By striving to understand multiple truths and perspectives, crystallization aligns more with

Interpretivism, the epistemological paradigm I used to conduct my research, which defines knowledge as negotiation of cultures, social settings, and relationships (Denzin & Lincoln, 2005).

Reactivity

Reactivity, or the influence of the researcher on the setting or participants (Maxwell, 2013), was a second possible validity threat. As discussed previously, I was an active participant observer; thus, my influence was potentially greater in the HRE as I was at times assisting, aiding, and teaching participants with their photovoice projects and field studies. However, even if I were to take a strict observer role, Maxwell (2013) argues, “eliminating the actual influence of the researcher is impossible” (p. 125). He goes on to suggest that the goal is to understand the researcher’s influence and to use it productively. Therefore, I employed steps to prevent negative influence, such as asking leading interview questions, but I did not attempt to minimize my overall influence, as Maxwell does not view this as a meaningful goal for qualitative research. To guard against negative influences, I asked other educational researchers to review my protocols (Merriam, 1995; Patton, 2002). In addition, I performed member checks, as described above, to ensure I was genuinely interpreting the words and actions of my participants (Creswell, 2012; Maxwell, 2013; Merriam, 1995, 2000; Patton, 2002). My long term involvement in the HRE, multiple data sources, and intense collaboration with the participants provided multivocality, which gave space for multiple participant opinions and presents a more complex and in-depth explanation of the participants and setting (Tracy, 2010).

Ethics

In discussing researcher ethics, (Lichtman, 2010) suggests that "it is neither possible nor desirable for researchers to keep their values from influencing aspects of the research study" (p. 20), and Merriam (2000) labels a "good" qualitative study as "one that has been conducted in an ethical manner" (p. 29). Furthermore, ethical research practices are one of the eight "big-tent" criteria Tracy (2010) describes in her framework of what constitutes quality qualitative research (the other seven being worthy topic, rich rigor, sincerity, credibility, resonance, significant contribution, and meaningful coherence). Thus, I implemented guidelines that assured I addressed procedural ethics, situational ethics, and exiting ethics (end of research study ethics) (Tracy, 2010).

I adhered to the procedural ethics put forth by the Institutional Review Board of The University of North Carolina at Greensboro. I avoided deception and coercion by ensuring that my participants understood that their participation in the study was voluntary and their decision to take part in my study had no impact on their standing in the HRE or the Academy. I refrained from collecting data on any student who did not give informed consent to participate in my study. Participant names and identifying information were kept confidential.

Since circumstances and situations continually change, I constantly reflected on my data collection methods to ensure data I exposed were not compromising to any of my participants (Tracy, 2010). As recommended by Schram (2006), I indirectly reminded participants about why I was there by keeping my note taking conspicuous. I also tried to be clear about my motivations and intentions when I conducted interviews, so participants understood that I was trying to obtain their meanings of events, activities, or something else and not my own (see Appendices 3, 4, 5, and 6). As Maxwell (2013) discusses, I tried to be aware of how my participants might perceive my actions; thus, I was cognizant of not observing to the point that my participants felt as though they could not be themselves or engage fully in the activity. In regards to exiting ethics, I used pseudonyms when analyzing my data and presenting my findings, and I shared my findings with the instructor of the HRE before submitting for publication. Additionally, I kept a research diary so that I could document the research process in order to continue my reflections on my role as researcher (Patton, 2002).

As with any research, there are possible validity threats I did not recognize and therefore have not guarded against; however, I attempted to minimize the ones that were apparent to me and to conduct my research in an ethical manner.

CHAPTER IV

FINDINGS AND DISCUSSION

The purpose of this study was to explore environmental education (EE) through an identity and equity lens by observing the participation of high school students in a field ecology program focused on herpetology. My goal was to develop a framework for Critical Environmental Agency (CEA) that builds on the work of science education equity scholars while incorporating principles widely used in environmental literacy and EE.

This study specifically examined how CEA was enabled in a field ecology program. The study was conducted and the data analyzed using an interpretative, ethnographic approach. Qualitative data sources (most significant for data analysis) included: field notes and observations, individual interviews, photovoice focus group interviews, and photovoice assignments. Quantitative data sources (less significant for data analysis) included: pre/post-tests and pre/post-surveys (attitudes, interests and perceived abilities).

This chapter discusses the findings of this study and is organized by the following research questions: (1) How were youths' experiences leveraged to develop their CEA during the field ecology program?; (2) How was CEA enabled during the field ecology program?; (3) How was CEA constrained during the field ecology program?

As each research question is discussed, salient themes, which arose during data analysis, are presented and discussed. Both qualitative and quantitative data analyses are presented, though qualitative data provided the most significant source for analyses.

Research Question #1

How were youths' experiences leveraged to develop their CEA during the field ecology program?

As discussed in Chapter 2, youths' experiences *belong in* and *broaden* EE (see Figure 1). By leveraging youths' experiences, youth are invited to be active versus passive participants in learning. Youth work together to co-construct their learning experiences. Viewing students as experts in regards to their own communities enables them to further develop their CEA (see Figure 1).

In order to answer this research question, four different data sources were used: (1) interviews, (2) observations and field notes, (3) photovoice focus groups, and (4) photovoice assignments. First, I searched the data for any instance where youths' experiences were highlighted during the course (e.g. where youth talked about their lives such as the neighborhoods they lived in or their prior experiences in the outdoors) and coded these accordingly. Youths' experiences were highlighted in several different ways during different events (see Figure 5). For example, participants told stories about herps, participants visited local community park areas to search for herps, and participants took photos of and discussed herps in their community. Ten initial codes were sorted and collapsed into three primary themes: (1) Youth as storytellers; (2) Youth as scientific explorers; and (3) Youth as community experts.

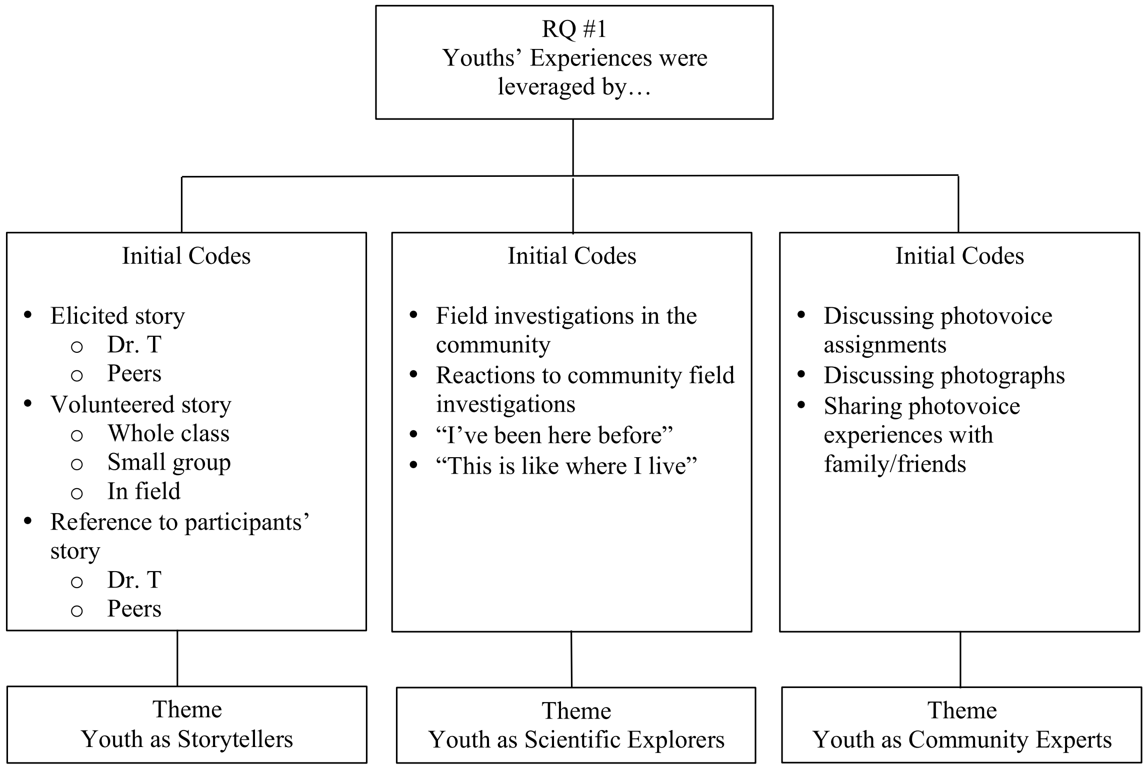

Figure 5. Themes for Research Question #1.

Youth as Storytellers

From the very first day of the Academy HRE, the instructor, Dr. T, established storytelling as a way for participants to not only share their experiences but also to divulge expertise, fears, loves, misconceptions, prior knowledge of and experience with herps, and experiences in nature.

An example of this storytelling approach, taken from field notes, is provided below. First, the context is provided for how Dr. T introduced storytelling on the first day of the course. Then, several examples are given of stories that youth shared that first day of class. The examples are grouped together by fear, misconceptions/misinformation and negative views, and previous positive experiences with herps. After each set of examples, I discuss how Dr. T and the other participants threaded these stories throughout the course.

> *Context for how storytelling was encouraged on the first day of the course.*
>
> Dr. T begins the first day of the Academy HRE by introducing herself and explaining the class expectations for the next four weeks. She ends the discussion about how "our class community is to act and speak in the next few weeks," by stating, "you will learn from each other as much as you learn from me."
>
> As the class transitions into an introduction to herpetology, Dr. T asks the scholars to introduce themselves by stating their name and then sharing a herp story with everyone. Realizing everyone might not yet have a herp story, Dr. T says, "Don't worry if you don't have a herp story yet because we will make sure everyone has at least one before this class is done. If you don't have one now, you can tell us why you decided to take this class."
>
> Dr. T gives the scholars a couple of minutes to consider what story they would like to share, and then she asks for volunteers. Seven students raise their hand to volunteer. Dr. T selects Kamal to share first (Field notes, 6/17/13).

> *Example when fear was revealed*
>
> Kamal - When I was little, I was 4-5 years old. I was laying in the grass, and a frog jumped into my mouth. I spit it out. I ran in and told my mom. Mom said I would get a wart on my tongue, which is probably **why I am so scared of small things**. Ever since then**, I have been scared of frogs, toads, and small things** in general. I am scared of mice. Anything that moves that is small. (Field notes, 6/17/13, emphasis added)

Kamal was the only participant to share his fear on the first day of class, and for the remainder of the HRE, Dr. T and the other participants were cognizant of Kamal's fear of frogs. Each time frogs were in the classroom and before field investigations, Dr. T quietly reminded Kamal that he did not have to hold or catch frogs unless he decided he wanted to touch one. However, she and the other scholars still encouraged him to interact with frogs. In the classroom, he observed and held containers but he never chose to hold a frog.

At one point in a field trip to University Forest, a small American toadlet that had been captured, escaped from its captor's hands, and everyone started yelling, "Someone get the frog. We haven't identified it yet." The only person within reach of the toadlet was Kamal. Without hesitation, he reached down and caught the specimen. Dr. T, several feet away, loudly said, "Way to go, Kamal! Did everyone see that skill? You'd think he had been doing that his whole life. Excellent work!" (Field Notes, 6/28/13). The following Monday (which was the next day the course met) Dr. T praised Kamal's bravery by having Kamal retell the story.

> Kamal – I just knew we had to get the frog. I didn't like it, but I knew I needed to grab it because I was the only one there. For some reason, he (the frog) decided to come my way. It wasn't as bad as I thought but he was jumpy.
>
> Kadence – Now do you want to hold a frog in class?
>
> Kamal – Nope. I mean no, thank you.
>
> Dr. T – That's okay. You held one when it mattered.
>
> Kamal – Yeah, but I was glad when you (Dr. T) took it.
>
> *The whole class giggled as Kamal said this last line. To end the story, Dr. T calls for a round of applause for Kamal* (Field notes, 7/1/13).

As seen by this exchange, youth were invited to share their experiences (storytelling), and their experiences were celebrated and incorporated into the classroom structure. The next set of examples portrays how negative views and erroneous information were sometimes shared during storytelling.

Example when misinformation or negative views of herps were conveyed

> Gary – I was at my grandma's house out in the country. I was playing basketball, and I saw a snake. All of sudden **it started trying to bite me**. **It was hissing and stuff**, so I ran in. **My grandpa killed it by chopping its head off**. I was going to scoop it up, but it jumped again and I jumped.
>
> Kadence – So basically I ride my bike for transportation. There was a turtle about to cross the road. It was about to get hit by a car, so I had to run into the middle of the road. **I had to walk my bike home because I had to hold him** (the turtle) **in my hand**.
>
> Alicia – I think I was in middle school, and **there was a snake in a tree. It rattled its tail.** My dad saw it because he grew up with snakes. **He threw a stick at it but it started chasing me.**
>
> Barbara - I am one of the SRAs (Student Research Assistant - this designation is given to returning students, who have already completed the summer course), and I took this (class) last year. It was so awesome, so I decided to come back. When I was younger, my brothers had this fish tank, and they decided that they were going to make it into an **amphibian tank**. They had **skinks with blue tails**, and they let one loose in the house. It was in the house for months. Mom was washing clothes and the skink ran out from the washing machine. **It had survived a load of laundry**. (Field notes, 6/17/13, emphasis added)

Though the four stories above conveyed misinformation or negative views of herps, Dr. T did not stop the scholar from sharing nor did she instantly correct the misconceptions, such as Barbara stating skinks were amphibians. Rather, she again sought out opportunities to address these points of view during the course. When lizards were introduced to the class, Dr. T made sure I *emphasized how a lot of people mistake skinks for salamanders*, and we discussed as a class why people might draw this misconception. I also created a picture game for the scholars to test their skill at distinguishing salamanders from skinks. In fact, Barbara, on her own accord, decided to include this information in the video Casey and she developed as part of their SRA assignment. She insisted on the script having a skink explaining how it made them sad when people mistook them for salamanders, and then, the skink proceeded to explain how one could learn to tell the difference between skinks and salamanders (Field notes, 6/27/13).

When Dr. T introduced snakes the last week of class, she used both Gary's and Alicia's stories in discussing the behavior of snakes. She mentioned that *tongue flicks* often scared people and led to people thinking the snake was trying to bite them. This led into a discussion about how and why a snake might try to bite a person. Dr. T also pointed out how some snakes will *rattle their tails* like rattlesnakes even though they are not rattlesnakes, and she said, "Remember Alicia told us at the beginning of the course about seeing a snake rattle its tail."

When a turtle was found on the road during the ephemeral pool field investigation, Dr. T and the other participants made sure Kadence saw the turtle. Even though Dr. T had not planned for students to see, let alone hold, a large semi-aquatic turtle called a Cooter on this trip, she did not hesitate to help Kadence hold the turtle when Kadence asked to do so. Dr. T also used this opportunity to quiz scholars on what they should do *if they find a turtle on the road*. Kadence instantly spoke up and said, "I know now. You should carefully pick up the turtle, unless it is a snapping turtle, and **you place it several feet away from the road,** making sure it is on the side of the road it was headed toward **even if you think it is cute and want to take it home**" (Field notes, 6/20/13, emphasis added).

Scholars also remembered each other's stories, and two photographs that were taken of turtles for the photovoice project were shared with Kadence even though she was not in the photographers' focus groups. During another field investigation, scholars also kept Mr. J (North Carolina state herpetologist) from putting a small snapping turtle back into the pond until Kadence had made it to the pond to see the turtle.

As seen in this set of examples, youths' experiences became a foundation for sharing and learning throughout the Academy HRE. Stories were not simply shared and forgotten. Rather, stories were means of conveying important and valuable information about the participants, including their fears and loves. The next set of examples of storytelling provides positive examples of interactions with herps and demonstrates how different levels of student expertise were utilized during the Academy HRE.

Example when positive experience/expertise was presented

Andy – One of my teachers **had a gecko**. I was dumb enough to put my hand in and it bite me.

Elaine - I use to go **catch tadpoles** at the park.

Kimberly - When I was little **I had pet snakes**. They were green snakes.

Mary – They have a bunch of them (pointing to anoles in the back of the room) at my grandparents house.

Tabitha – When I was little, I had **a pet frog**. It was tiny like the size of my thumbnail.

> Quincy – See what happened was Dr. T took us to the mountains to see salamanders, and **we saw this toad eat** and it was cool. It ate real fast.
>
> Patrick - Dr. T took us out and we **held salamander eggs**, and it felt like jelly. (Field notes, 6/17/13, emphasis added)

Those students, who had previous experiences with herps, were assigned leadership tasks when the particular herp they were familiar with was discussed in class. Even though Quincy and Patrick had only participated in a handful of herp activities prior to the Academy HRE, Dr. T still positioned them as leaders and asked them to help other students whenever new herps were introduced to the class. She also asked them to share more about the mountain trip when she introduced salamanders to the class, and both participants shared stories with their individual groups, as they were working with animals.

Kimberly was the first student Dr. T had hold a snake, and before giving Kimberly the snake, Dr. T said, "I remember you said you had a pet snake, so you are an old pro at doing this" (Field notes, 7/8/13). Dr. T placed Tabitha and Elaine as group leaders during the ephemeral pool investigation, reminding the class that each girl had prior experiences with frogs. Mary and Andy were asked to remind the class how to hold a lizard, and Andy commented "Remember, anything with a mouth can bite (a statement Dr. T made every time live animals were handled in the classroom) and believe me lizards can bite, well at least I know geckos can" (Field notes, 6/25/13), which made the class laugh.

Throughout the month-long course, storytelling was encouraged. At the beginning of each class, Dr. T asked, “Does anyone have a story to share with us today?” (Field notes, 6/18/13). After the introduction of the photovoice project at the end of week 1, stories expanded to include general nature experiences and encounters with organisms other than herps. For instance, the excerpt below is from class after the participants’ had been home for the first weekend.

> Dr. T – So, does anyone have a story to share from this weekend?
>
> *Kadence is literally bouncing up and down in her seat with her arm fully extended. She does not wait on Dr. T to call on her but proceeds to address Dr. T.*
>
> Kadence – I do. I have a story, but it’s not a herp story. It’s a, well a general nature story. Is that okay?
>
> Dr. T – Absolutely.
>
> Kadence – Well, I was at my grandmother’s house, because I live with her, taking photographs, and she has some really pretty flowers growing. So I said to myself, “I should go take a close up photo of some flowers because that will be pretty.” So I had my camera up to my eye and I was peeping through the eye hole trying to focus, and as soon as my camera focused, I realized there was a bee inside the flower. I normally would have screamed at this point and ran into the house, but I couldn’t move. I was just overwhelmed by the detail. I could see the pollen all over the bee. I took several photos. Then, I looked at them on the camera and zoomed in some. I could see leg hairs on the bee. It was amazing. The first time I’ve not ran from a bee. In fact, I think I might like ‘em now.
>
> Dr. T – Kadence, that is fantastic. That is exactly what we want the photovoice project to be about, you being immersed in nature. Great story. Who’s next? (Field notes, 6/24/13)

Kadence proceeded to share the bee photograph (see Figure 6) during that week’s photovoice focus group (Focus group, 6/25/13), and she referred to this event five other times during the course, even sharing the story in her exit interview when she explained about the photovoice project.

Figure 6. Photograph by Kadence Shared during First Photovoice Focus Group.

As illustrated by the examples in this section, storytelling was an important part of the Academy HRE. Dr. T often ended class by saying, “Remember today is another opportunity for you to find a story.” In fact, 15 out of 16 participants volunteered at least one additional story during the four weeks of the course. Elaine was the only participant who did not share a story with the entire class, though she did tell stories in her photovoice focus groups. Ten of the participants voluntarily told three or more stories to the large group. Dr. T and the other participants did not challenge a volunteered story, even if the story conveyed misinformation; however, Dr. T did address the misinformation at other times during the course. It is important to note that Dr. T required participants to share a story only on the first day of class; the participants volunteered all other stories shared during the 4-week course. Though Dr. T did sometimes ask a participant before class if they would like to share a particular story, such as when Kamal captured his first frog, she did not do this in front of the large group, and participants were able to decide for themselves whether they wanted to share the story.

Storytelling is a central practice of field ecology, as Bowen and Roth (2007) discovered in their ethnographic study of field ecologists. Sharing anecdotal “tales from the field” enable field ecologists to build social communities, share observational data, and develop insights regarding the ecosystem. Bowen and Roth (2007) also found that in particular sharing “heroic stories” involving “elaborate tales of personal experience” solidified one’s social position within the community, and membership within the community is established by common shared field experiences. Tan et al. (2012) also advocate the use of storytelling in classrooms, as they contend that incorporating student narratives into the classroom offers a platform for meanings to be negotiated between teachers and students. This in turn provides more equitable opportunities for learning as students’ stories create potential entry points into science. Thus, the emphasis on storytelling in the Academy HRE closely reflected the practices of field ecologists and served to provide opportunities for students to leverage their experiences, which made the learning experience more personal and demonstrated to the participants, that their experiences were important and mattered.

Youth as Scientific Explorers

As mentioned in chapter 3, this was the fourth time the Academy HRE has been offered. Each year, Dr. T has worked to identify areas in the county, where the youth live, to conduct herpetological field investigations. For 2013, Dr. T was able to hold two out of three field investigations in this county. She added a fourth community field investigation when a scholar (Casey) and his family offered to host a field investigation on their property. A description of each field investigation that occurred in the county is provided, and then, I provide examples of how the youth responded to these field investigations.

Box Turtle field investigation. This was the first field investigation for the course, and it involved using trained Boykin Spaniels dogs to sniff out and find Box Turtles. When Box Turtles are found, the turtles are processed (weighed, measured, and photographed), marked (an individual identification code is filed on the peripheral scutes of each turtle) to begin a mark/recapture study, and then released.

For this investigation, Dr. T selected an urban county park (City Park) that all of the students had been to before, and it was also the sight of a community science day hosted by the HERP Project in the Spring of 2014. City Park is located in the heart of the county and has over 75 acres of land. It has an amusement area with rides for children, athletic fields, buildings for indoor events, picnic shelters, tennis courts, and walking trails. This was the first time Dr. T had brought scholars to this park.

On the day of the field investigation, the scholars were very excited, and there was constant chatter in the room as the youth readied themselves for the field. Below are excerpts of conversations that occurred as everyone was walking to the van.

> *Kadence, Barbara, and Casey are in the lead and walking briskly toward the vans.*
>
> Kadence – I go to City Park all the time. I love the carousel.
>
> Barbara – Me too!

Casey – I played baseball there when I was younger. The fields seemed much larger than they do now.

Gary, Patrick, and Elaine make up the next group of students, and they are several steps behind the first group.

Gary – Do you think we will actually find any turtles?

Patrick – I don't know. All I've seen are squirrels.

Elaine – I caught tadpoles in the creek when I was younger.

Gary – Come to think of it. I've seen a frog there, once. I think.

Mary and Kimberly bring up the rear and appear to be lost in conversation.

Mary – My friends and I hang out at City Park.

Kimberly – I've been there with my family. I usually go to River Park with my friends. We walk the trails and look for animals. (Field notes, 6/18/13)

As can be seen from these field notes, the participants had varying experiences with City Park, which attests to the park being used by a wide array of people. Thus, instead of selecting a site unfamiliar to the students, Dr. T chose to take the students to a familiar setting, where they had played ball, rode rides, and spent time with friends and family.

Unfortunately even though the group walked the entire perimeter of the park, no Box Turtles were located on this day, which seemed to affect participants' perception of the Box Turtle field investigation. No youths mentioned this as their favorite field experience when asked to describe their favorite experience during the individual exit interviews. In fact, none of the participants mentioned the Box Turtle field investigation at all during the individual interviews. Though the interviews did not ascertain why the youth failed to discuss the Box Turtle investigation, participants' comments recorded during the investigation and provided on the final post-surveys offer some explanation.

> *Observations during Box Turtle investigation*
>
> Throughout the walk, four different participants (Jaylyn, Alicia, Kamal, and Casey) asked Dr. T if she had ever seen Box Turtles there. Two participants (Betty and Barbara) asked the park employee, who accompanied us, if he had ever seen Box Turtles. When he responded that he had, they responded with, "Really?"
>
> *The youth also seemed disturbed by the amount of trash around the park, and when the dogs crossed over into an area with a lot trash, a couple of students voiced this concern.*
>
> Betty – Oh the dogs could get hurt over there because there is a lot trash, and what if there is broken glass.
>
> Mary – I hope they don't eat anything over there. It would make them sick.
>
> *About half way through the trip, Kadence and Jaylyn have a brief conversation as Kadence stops to tie her shoelace.*
>
> Kadence – I'm not surprised they (turtle tracking dogs) aren't catching anything for us because we are in the heart of the city.
>
> Jaylyn nods his head – Yeah, me neither. (Field notes, 6/18/13)
>
> *Participants were asked on the post-survey to explain why they rated any investigation below a 3 on the post-survey.*
>
> Alicia – We didn't find any turtles in City Park.
>
> Jasmine – For Box Turtles with dogs we never found any Box Turtles, so we didn't have the opportunity to see a Box Turtle. (Post-survey data)

As suggested by the above examples, participants did not believe Box Turtles would be present in the park. They also appeared to judge the success of the project on whether Box Turtles were found even though for other investigations (such as University Forest) locating herps was not of paramount concern. Thus, another possible explanation for the participants' response to the Box Turtle investigation is that the group traveled together on a predetermined route. Participants did not have the freedom to decide where they went or the freedom to explore the area, which proved to be important themes for CEA and will be discussed later when I present the findings for research question two. It could also be argued that the Box Turtle field investigation was during the first week of the course, so participants were more removed from this activity. However, the ephemeral pool field investigation, which was located in an adjacent county on private land and thus is not discussed in this section, was conducted the day after the Box Turtles field investigation, and each participant mentioned the ephemeral pool field investigation during the individual interviews. Thus, even though the Box Turtle investigation occurred in the participants' community and all 16 participants had previously been to the park, it was not as successful as the other field investigations.

University Forest. One goal Dr. T had for the 2013 Academy HRE was to help the scholars consider and experience various types of habitat. Thus, she planned a trip to University Forest with two university ecologists. Most of the scholars (n=12) had never been to University Forest even though they spent a month each summer on the University's campus, and the forest was within walking distance from the campus, about 10 minutes from central campus.

The goal for this field investigation was for the scholars to experience local forest habitat and to conduct a herp survey, which means they scanned the forest for any type of herp they could find. In order to complete the survey, the participants rolled over downed logs, sifted through leaf litter, and surveyed the ground as they walked through the forest. A secondary goal also developed as there were several small ephemeral pools in the area, and the scholars were able to compare them to the large ephemeral pool they had surveyed in their second field investigation. The large ephemeral pool was located in the adjacent county; therefore, it is not described in this section.

Since the forest was so close, the participants were transported by one van in two trips (as opposed to the two vans that were normally driven on field investigation days). This required the students to be divided into two groups, and I was assigned to travel with the first group. A chorus of "This is so cool. Look we get to climb a fence. Look at all the trees." could be heard as the first group of participants poured forth from the van (Field Notes, 6/28/13). Both groups were surprised at how close to campus the forest was and they were not even aware of its existence.

> *Conversation recorded as participants are walking through the field on the way to the forest.*
>
> Alicia – I can't believe I have lived on campus and never knew about this place. (*Comment made to Kadence as they are walking through the small field. Kadence nods her head*.) (Field notes, 6/28/13)
>
> *Conversation recorded as participants are standing near Dr. T. The small group had just finished a discussion about slugs, and Dr. T is returning a slug to where they captured it.*
>
> Kimberly – Are we allowed to come here by ourselves?" (*Question directed to Dr. T*)

> Dr. T – Yes, this area is open to students. There are probably a lot of University students who don't know this is here.
>
> Betty – So, we can come here during the school year?
>
> Dr. T – Yes, you can. (Field notes, 6/28/13)

The University Forest field investigation was mentioned often during the individual interviews. When asked to describe her favorite field experience during her interview, Betty described the University Forest field investigation.

> Betty – University Forest even though we didn't find much. We found a couple of frogs and a slug and some millipedes, but we didn't really find that many like cool things. So we were just kind of looking to have fun. But, I felt like that was my favorite, because we were all there and even though we were in separate groups, we were still calling to each other like hey we found this. Or hey we found a millipede and I actually surprised myself because we found some slugs and when I see slugs on my porch I pour salt on them. I know that's really horrible, but Dr. T picked it (the slug) up and she's like look. And we're like you're crazy. We're not touching that and then she grabs my hand and she's like no, I'm serious. I was like okay, fine I'll hold it this one time, but you're not allowed to tell anybody that I held this thing. And it crawled onto my hand it was crawling on my fingers and stuff and it was actually kind of cool, because I'd never done that before. (Exit Interview)

During the exit interview, when asked to describe a time when she felt like she was truly learning about animals and/or their habitats or their population, Mary also chose to discuss the University Forest investigation.

> *When asked why the University Forest field investigation would in her memory,*
>
> Mary – Because it was like **a five minute drive** from the big campus, and then like all of a sudden we were in nature and there were like frogs and spiders and vegetation. (Exit interview, emphasis added)

When asked to respond to the same question during her individual interview, Tabitha responded with,

> Tabitha – Well, whenever we went out to the University Forest and at Casey's house we saw a bunch of animals. Like we saw slugs, anything from slugs to toads to – we saw a dead snake, spiders – I hate spiders. But then like it was a **really good opportunity to explore our community** and learn a little bit about everything all at once. And so you learned a lot and it just felt like you were getting all this information but it seemed like you – it's like you can take it in naturally and it's not getting pushed on you. (Exit interview, emphasis added)

Elaine also provided insight into participants' reaction to the University Forest field investigation when she described a time that she felt "sciency" (like she was actually doing science) during her individual interview.

> Elaine – When we were outside in the University Forest, we were looking for stuff, and we were identifying the different frogs, salamanders, and such.
>
> Interviewer – How did you identify them?
>
> Elaine – We have a field guide that we go through and we had to name three characteristics for it and then we see if it's that or not or something else. (Exit interview)

During their individual interviews, Andy, Jaylyn, and Patrick named the University Forest field investigation as a time during the Academy HRE when they had felt particularly proud of themselves. All three described how they were able to attach animals and share them with their peers. As seen in the examples provided, participants were able to make connections to University Forest, and this field investigation was successful in connecting scholars to their community and to science.

Herp BioBlitz. During the first week of the course, Dr. T was approached by Casey, one of two scholars who were in the Academy HRE for a second summer, about conducting a herp survey of his property. He informed Dr. T that his mother had given him permission to invite the class, so Dr. T worked to plan the field investigation to Casey's house for when the state herpetologist, Mr. J, would be visiting the class.

The objective for this field investigation was to conduct a herp bioblitz, which consists of completing a survey of the property and identifying all amphibians and reptiles that are found. To achieve this goal, Dr. T had Casey help her divide his property into four quadrants, and then she put the scholars into four groups. Casey, Barbara, Dr. T, and another Academy staff member led the groups. Casey and Barbara were selected because of their roles as Student Research Assistants (SRAs). Throughout the morning, Mr. J traveled between groups helping them look for and identify any amphibian and reptiles that were captured.

Since all the youth were from the same county, they were familiar with the area in which Casey lived, and one of the participants, Kimberly, indicated that she was from the same part of the county, while Gary and Jaylyn had grandparents and other family that lived in the area. The scholars were excited about going to the area, and many expressed curiosity about where Casey lived. Several questions were posed to Casey as the scholars walked to awaiting vans (Field Notes, 7/2/13).

Kamal – How many acres you got?

Casey – We have five acres.

Betty – Don't you have horses? Can we pet them?

Casey – Yes, my sister has a horse.

Tabitha – What kind of herps have you seen before?

Casey – Lots of 'em, especially frogs. We have a pond with some aquatic turtles in it, so I'm hoping we catch us a Painted Turtle.

Tabitha – That'd be cool. (Field notes, 7/2/13)

Even though this was the first year Dr. T had conducted this field investigation, six participants described this as their favorite field experience during their interview. The interview excerpt from Tabitha provided below demonstrates how youth connected to this experience, as they both describe Casey's house as their favorite field investigation.

> Tabitha – I'd have to say probably Casey's house, because we did a lot of things from catching a snapping turtle to catching a dead snake to catching frogs and things like that and it was a bio blitz. And we got to learn a lot and I think it was my favorite experience I've ultimately had, **because it was our community**. And it was something that we – **we could go to our backyards and do**. Like if you live in the country, you could just go to your backyard and do that stuff.
>
> And most people don't think about doing all of that – all those things. Like at their own house, they usually go to museums to do it. And it's just good to know – it's good to learn how you can do that at your own house. (Exit interview, emphasis added)

Five participants used the Herp BioBlitz has an example of a time during the Academy HRE when they felt like they were truly learning, as shown by the interview excerpt from Jaylyn below.

> Jaylyn – When we were in Casey's backyard doing like a BioBlitz. He had a swimming pool in the back of his yard. He had a lot of woods in the back. He had a pond and he had a pool, it was like falling down and stuff. We caught a lot of

> stuff there. I can't remember everything. I know we caught a Green Frog and like when we caught it. Mr. J explained why it's here, what it's doing during this season and why it's floating in this certain pool cause some animals can't live without ephemeral pools because they have to have somewhere to lay the eggs so fish can't get them.
>
> And that really like opened up to me where certain animals will live and like how frogs live in trees and they come down to mate and things like that. It really showed me why they live in certain places. (Exit interview)

When asked to describe a "wow" moment, a moment that they would never forget, during their individual interviews, Mary and Elaine participants shared stories about the Herp Bioblitz.

> Mary – It's kind of dramatic but when we were at Casey's house. He was trying to catch a frog. Like it got under the tarp or a piece of wood and got away. I just thought really fast and I grabbed it right next to my boot and just said, 'Well so you know, I just caught a frog with my bare hands in 'the wilds', you know, I got this.' I just had that instinct, and also because I associated with, if I caught one, that I would like squish it or hold it too loose or something and I caught it, was holding it, and I didn't squish. (Exit interview)

> Elaine – I think when we went to Casey's house where we were looking at the frogs. I really liked the frogs and I actually got one. I really didn't want to hold it but I actually did so. (Exit interview)

The examples provided show how participants were able to engage new experiences in environments that not only felt familiar but were also considered part of their community. The repeated opportunities to engage in herpetofauna surveys of local areas enabled participants to develop their observational skills and led them to ask questions to deepen their understanding of herpetology and the underlining scientific concepts, which will be discussed in more detail in research question two. In this regard, Bowen and Roth (2007) discuss how important prolonged exposure is for field ecologists, and they ascertain that field ecologists need time for observational study in order to become more fully aware of their surroundings and better develop their research questions. In addition, EE scholars advocate for repeated exposure to natural areas, as a means of developing students' concept of place and strengthening their sense of place (Bogner, 1998; Kudryavtsev et al., 2012). Thus, having field investigations in the local community encouraged participants' development of observational skills needed in field ecology and provided opportunities for students to forge attachments to local natural areas by demonstrating the importance of understanding and learning in one's community.

Youth as Community Experts

The photovoice project was another new curriculum addition for 2013. The purpose of the project was to encourage youth to spend time in nature during their weekend home visits. The youth were provided with cameras and told to take photographs of any herps they found and of areas that could be good herp habitat (see Appendix B).

The photovoice project was introduced on the fourth day of class, and Dr. T reviewed the assignment for the weekend (see Appendix B). Below I capture the classroom conversation that occurred as the photovoice project was discussed.

As the cameras are being distributed, scholars ask several questions of Dr. T.

Betty – So we really get to take these (cameras) home?

Dr. T – Yes. We want you to take photos of your community.

Alicia – What if we have our own camera? Can we use our own camera?

Dr. T – Yes, just let us know when we go to assign you a camera number.
Jaylyn – Can we take any photograph?

Dr. T – You can take any photograph you want. For this class, you need to focus on nature photographs, and we will be taking up your cameras to download the photos so make sure you are "okay" with people seeing the photos you take.

Class giggles as Dr. T uses air quotes over the word okay.

Lacey – I will burn all the photographs you take onto a DVD at the end of the program for you, so if you have extra photographs, that is fine.

Kimberly – So if we take more than six photographs this weekend, what do we do?

Dr. T – You take as many photographs as you like, but try to come back to class with your top six. The six you think best represent what you were trying to capture. You decide what is important for us to see. (Field notes, 6/21/13)

Participants are chatting at their tables as they practice using their cameras, by taking photos of each other and frogs that are located in containers on the table.

Conversation recorded at table consisting of Barbara, Casey, and Kimberly.

Casey – I love taking photos. This is so cool.

Kimberly – I know. I've also wanted to do nature photography. I didn't realize this class did that, too.

Casey – I'll probably come back with a hundred. I really want to capture how my neighbor is cutting down all the trees on his property. (Field notes, 6/21/13)

Conversation recorded at table consisting of Alicia, Betty, Elaine, and Jaylyn.

Betty – What are you going to take pictures of?"

Jaylyn – I don't know. I don't think I'm very creative.

Alicia – Look at Instagram for some inspiration.

Betty – Plus, it's not like school. We aren't getting a grade. There isn't a "right" answer. (*Betty used air quotes over the word right*)

Jaylyn – That's true. I think I might go to my grandparents because they live out in the country and have lots of good habitat. (Field notes, 6/21/13)

As the class prepares to leave for the weekend, Dr. T asks if there are any questions regarding the photovoice homework.

Kamal – But Dr. T what type of photograph do you want to see?

Dr. T – You get to decide what we see. You are the resident expert. You know your community, you know its strengths and weaknesses, and you get to introduce it to us. We are not looking for any "type" of photo. Most importantly, have fun and spend some time outdoors. The weather is going to beautiful. (*Dr. T used air quotes when she said the word type.*) (Field notes, 6/21/13)

As seen in these field notes excerpts, Dr. T acknowledged that the participants were the experts when it came to knowing their community. The students were the only ones to decide what photographs should be taken and shared.

Students' experiences were also highlighted during the photovoice focus groups as they discussed their photos with each other using the modified *SHOWeD* protocol (see Appendix A). Below is an excerpt from Dr. T's first photovoice focus group with Jasmine, Andy, Kimberly, and Mary. Jasmine volunteered to share her photo first. (see Figure 7).

Jasmine holds up her photo for the other participants to see. The other participants comment on the different types of grass and the leaves in the photo before Dr. T asks Jasmine to describe the photograph.

Jasmine – It's not in my backyard. It's in a friend's backyard. Like I couldn't really find any herps, so I just took a picture of the grass because they could be there even though I didn't see any. If they weren't right in that one spot, they could be in other areas. I tried to take it from the angle of the animal. They can use the leaves to hide and for shade.

Dr. T – That's a good point because my husband and I have this same argument when we have leaves on our yard. He wants to rack them up and I always say leave them there. So some people might look at this as a dirty yard while others see it as providing habitat.

Dr. T reading from protocol– How can we use this to educate others?

Mary – Don't rack the leaves in your yard. *Group laughs*.

Jasmine – Yeah. Just be aware of what might possibly be on the ground.

Andy – Leave a place for animals. Like I said in agriculture if you have a farm, you have bush piles for wild life, so this is kind of the same thing.

Dr. T – Yes on a miniature scale. (Focus group, 6/25/13)

Figure 7. Photograph by Jasmine Shared during First Photovoice Focus Group.

As seen in this example, Jasmine took a photograph that represented potential herp habitat sites in her community. In Jasmine's example, Andy was able to relate to what Jasmine was trying to show about habitat to his experiences in agriculture. Jasmine was also able to think from the perspective of a herp to find potential habitat in her community.

Participants also discussed how they were responsible for determining what photographs were shared in their individual interviews. Below are some examples of participants describing the photovoice project during their individual interviews.

> Elaine – I thought it was cool because you got to see other people's pictures and **everyone had like a different viewpoint** on a picture, because **you really didn't know what was going on because you weren't there and you don't live there**. But, the person who had the picture could tell you and it would give you a new idea of what was actually going on. (Exit interview, emphasis added)

> Kimberly – It was really cool, because I had taken a photography class this past year and it was really cool to be able to **go out and know what I was looking for** and actually know what I was about to take a picture of. It was different in the photography class because I had to realize the meanings behind it and what it can actually teach people. (Exit interview, emphasis added)

> Quincy – I thought it would be kind of hard, because like I looked at all them questions and they got me thinking. I think that was good. But at first I didn't really get why we were doing it. But then as we kept going on I kind of started liking it**. It got us thinking about habitats** and thinking about like pictures and **what we observed and were seeing**. **What we see in the picture and what we think about it and how we interpret it**. And how we can help others understand what we see. (Exit interview, emphasis added)

As the examples presented in this section document, the photovoice project served to further leverage students' experience by positioning them as community experts and allowing them opportunities to highlight the strengths and weaknesses they witnessed in their communities. Recognizing students as community experts enabled participants to exhibit agency in the classroom by determining which photographs to take, which ones to discuss, and which aspects of their community they desired to highlight. As Calabrese Barton and Tan (2008) discuss, youth from low socioeconomic status families "are often positioned as recipients of expertise rather than participants in the use and further construction of expertise" (p.190). Thus, the Academy HRE provided an equitable environment in that participants shared expertise in the classroom.

Summary: Research Question #1

Participants' experiences quickly became a central part of the Academy HRE. By encouraging storytelling, youth were shown that their experiences helped to support and enhance the Academy HRE curriculum. Field ecologists often engage in storytelling with each other and much of the known cultural, social, and natural history of field sites are exchanged via stories (Bowen & Roth, 2007). Thus, by promoting storytelling in the HRE, participants were also exposed to the practices of field ecologists.

Tan and Calabrese Barton (2010) emphasize the importance of community-centered investigations in their study of student agency in an after school science program. The field investigations and photovoice project provided the same types of opportunities for participants in the Academy HRE. Casey was able to exhibit agency when he helped plan a field investigation at his house, and the other participants exhibited agency and expertise as they determined what should be photographed in their community and what stories should be told.

As indicated in my conceptual framework, youths' experiences must be utilized in order to enhance the opportunities afforded to youth in developing their CEA. Thus, I needed to explore and then explain how the Academy HRE leveraged youths' experiences. Through storytelling, community field investigations, and the photovoice project, youths' experiences were valued, honored, and encouraged as a critical part of the Academy HRE.

Research Question #2

How was CEA enabled during the field ecology program?

As discussed in Chapter 3, the Academy HRE was selected as the study site because it offered a 4-week residential course within a long-term college access program, with the mission to inspire academically promising underrepresented students to pursue higher education, build leadership skills, and develop social responsibility. Given the mission of the college access program, the Academy HRE offered the most significant opportunity to develop the concept of CEA. Over the four weeks of the course, participants had multiple opportunities to engage and further develop the five principles that I believe comprise CEA.

In this section, I will present my findings for each principle by salient theme and then I will discuss any quantitative data used to further emphasize the qualitative findings. I will end this section by discussing the three overall themes that emerged and how these worked in concert to enable youths' CEA development.

Multiple data sources were used to answer this research question. First, I analyzed the qualitative data (individual interviews, observation and field notes, photovoice focus groups, and photovoice assignments) for each individual principal of CEA (e.g. for principle a, I searched for instances where learning occurred). Once I sorted the data by principle, I went back and recoded the data for each category, developing initial codes (e.g. for principle a, twelve codes emerged). To further clarify the findings, I completed a third round of qualitative data analyses by collapsing similar codes into three salient themes for each principle (see Table 5).

Table 5

Salient Themes that Enabled Development of Each CEA Principle

Principle a. Deepening understanding of content & practices	**Principle b.** Recognizing self as expert	**Principle c.** Developing critical consciousness of place	**Principle d.** Developing sense of place & discussing actions/issues	**Principle e.** Envisioning self & world differently
Identifying herps &/or discussing scientific concepts	"No one else did it"	Using the environment as a lens	Working through environmental discomfort	Developing newfound awareness
Having & asking questions	Recognition by others	Discovering & rediscovering habitat	Encouraging others	Educating others
Using animals as study tool	Contributing to science	"Beauty of the find"	Sharing with family and friends	Altering feelings toward herps

There were 14 codes that addressed multiple principles, so I also created an overall category for CEA. The three themes that crossed all five principles were: (1) Having the freedom to explore; (2) Having the freedom to decide; and (3) "Second chances." These will be discussed later in this chapter.

Next, the quantitative analyses were conducted to determine whether or not they supported the qualitative themes. The post-survey questions were coded and grouped according to CEA principle. Class and individual averages were calculated. Pre/post-tests were also scored and analyzed. Wilcoxon signed-rank and Wilcoxon rank-sum tests were conducted to assess whether there was a significant relationship between class gain scores, and ethnicity (Caucasian, non-Caucasian), gender, or grades (A's, non-A's).

It is important to note that though the five principles were treated as separate aspects during data analyses, principles a through e are intricately connected upon each other to support CEA. I isolated the principles to more clearly explain how each was enabled throughout the Academy HRE and to emphasize how each principle needs to be considered when CEA is applied as a theoretical framework.

Principle A

Gain a deep understanding of the sciences that inform EE and the processes, skills and modes of inquiry associated with the sciences.

The Academy HRE provided many varied opportunities for participants to deepen their knowledge and understanding of herpetology, field ecology, and nature of science. As an overall evaluation metric for the HERP Project, a pre/post-test was administered at the beginning and end of each HRE. For the Academy HRE, the participants saw the test as a way to measure their knowledge of herpetology; thus, I used the metric for this purpose (see Table 6).

As Barbara stated during her final interview, "I remember a lot of it (things learned during class), like with the final test. I'm flipping through it and I know the answers. So it's really exciting to see like how much I actually know." Several participants also made comments after the post-test.

Table 6

Pre/Post-test Results

Participant	Pre-test score[a]	Post-test score[a]	Gain scores
Alicia	16	37	21
Andy	16	33	17
Barbara	**29**	**36**	**7**
Betty	9	34	25
Casey	**27**	**29**	**2**
Elaine	13	32	19
Gary	12	29	17
Jasmine	4	23	19
Jaylyn	15	28	13
Kadence	14	34	20
Kamal	14	34	20
Kimberly	17	25	8
Mary	14	34	20
Patrick	17	30	13
Quincy	12	29	17
Tabitha	13.5	29	15.5
Class Average	**15.16**	**31.00**	**15.84***

Note. Bolded names were second year participants (SRAs).
[a]Total points possible was 44.
* $p < .05$.

Participants gathered in the hallway after they had completed the post-test so not to disturb students who were still testing.

Betty – I knew way more answers this time.

Jaylyn – I can't wait until I get my score back because I know I nailed it.

Kimberly – I was so excited when I heard the Cricket frog, and I knew what it was.

Casey – I bet I crushed my score from last year. Did you feel like that?" *Directs question to Barbara.*

Barbara – Oh yeah. I did so much better. (Field notes, 7/11/13)

Results from the pre/post-tests for the Academy HRE found that the class average increased by 15.84 points, which was significant ($Z = -3.522$, $p < .05$). No significant relationship was found between ethnicity, gender, or school grades and gain scores. All 16 participants increased their pre-test scores. Betty, who had the second to lowest score on the pre-test, had the greatest increase of 25 points, while the two SRAs (Casey and Barbara) had the smallest increases of 2 and 7 points, respectively. However, Barbara and Casey did have the highest pre-test scores and were the only two participants to score above 20 on the pre-test. Jasmine had the lowest score on the pre-test and post-test, but she did increase her score by 19 points, which was above the class average. Alicia had the highest post-test score of 37 and her 21-point increase was the second highest in the class. Thus, the test results indicate that the participants learned content knowledge during the Academy HRE.

Though the post-test shows the accumulation of students' experiences, students engaged with content both in the classroom and in the field. Patrick's response when asked to describe a moment he would never forget during his final interview demonstrates how students viewed the whole HRE as an opportunity to learn and engage.

> Patrick – I don't really have any one moment that stands out. Just going out into nature and finding herps and learning about it and being able to identify them. Meeting lots of herpetologists and asking questions in class. (Exit interview)

Analyses of my qualitative data rendered twelve initial codes for principal a, which were then sorted and collapsed into three salient themes (see Figure 8).

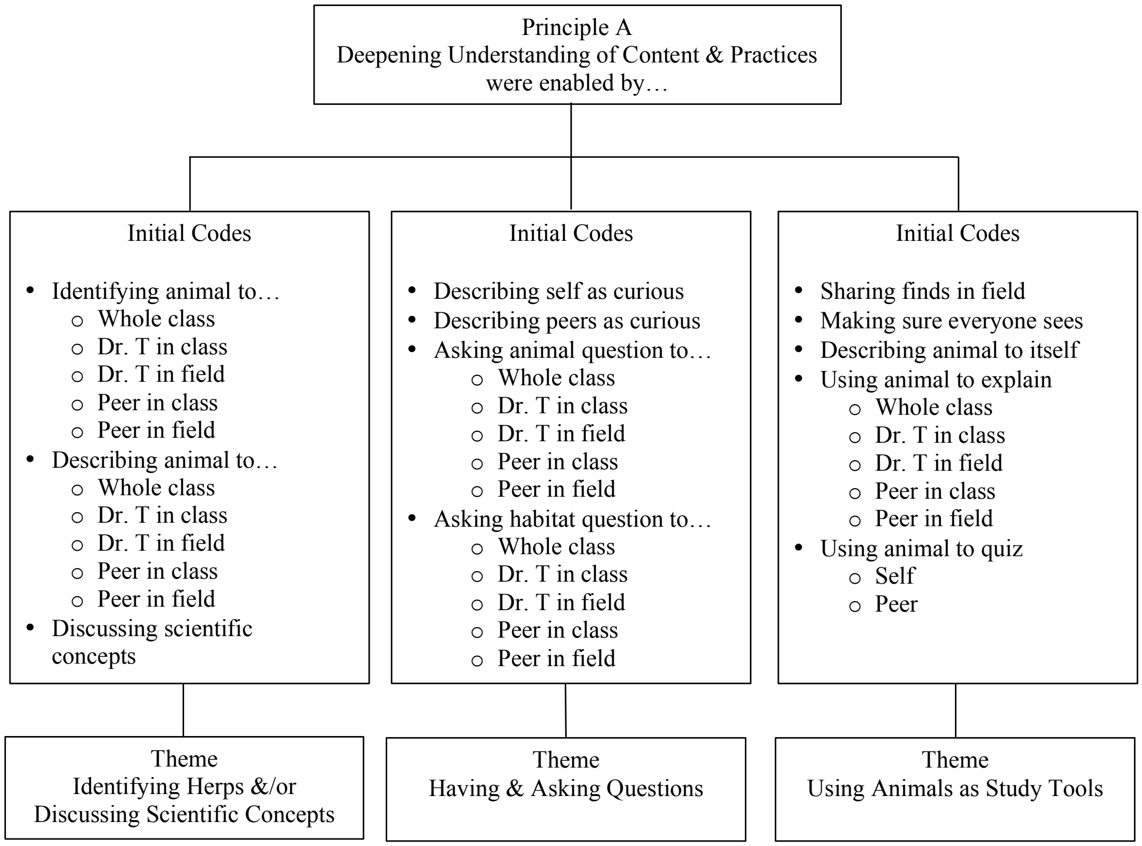

Figure 8. Themes for Principle A.

Identifying herps and/or discussing scientific concepts. A large majority of the Academy HRE curriculum was centered on learning to distinguish different groups of herps (frogs, lizards, salamanders, snakes, and turtles) and then identify specific species within each group. Scientific concepts, such as natural history of each herp group, population size, mark/recapture studies, and environmental threats to herps, and tools, such as minnow traps, aquatic turtle traps, and calipers, were also presented and discussed. Every participant mentioned at least one specific herp during the exit interviews, and 13 of 16 participants discussed a scientific concept and/or tool. The photovoice project also provided multiple photographs of herps and students often discussed how one could use the photographs to educate others about the specific herps. Examples are provided below.

Examples of discussing specific species (emphasis added)

When asked to describe why the ephemeral pool was his favorite experience,

Jaylyn – We caught baby salamanders. They were **Spotted Salamanders** because those are the main ones during that season (summer). (Exit interview)

When asked when he felt like he was learning, Kamal mentioned the Green Anole and the interviewer asked a follow-up question.

Interviewer– So you mentioned learning about the **Green Anole**. Can you tell me about it? Because I don't know a lot about it.

Kamal – So like males they – they have like a – I guess it's like a square. It will be three meters across and so if another male steps into that square, then the males release their dewlap. And that's really cool to see them (display their dewlap) – They start pumping their arms like they're doing push-ups or something like that to threaten the other male. It's really funny. (Exit interview)

When asked to describe a time she felt she had learned,

Alicia – The frog calls – there's a bunch of **Fowler's Toads** out there (on the university campus), especially around the dorms and I hadn't noticed that until they taught me about the calls. And then at night, I was talking to my friend. I was like, do you hear that. That's a frog – that's a Fowler's Toad. And then they were like what – really what? Huh? And I was like yeah, I learned that in herp class (Academy HRE). You should take the class. And they were like oh, those are toads? And I was like yeah. (Exit interview)

When asked to describe his first capture of the summer,

Patrick – The **salamander larvae**, a juvenile salamander is the first thing I found this year.

Interviewer - So, how did you identify it?

Patrick - By the external gills.

Interviewer - And how did you know that?

Patrick - Because we learned about it in class before we went to the ephemeral pool. (Exit interview)

When asked to describe her favorite experience,

Elaine – I think my favorite experience was in the classroom with the frogs and holding them. We had to see if it was a girl or a boy so that was fun because you look under its neck and if it's black under there, it's a boy, if it's like a regular color it's a girl.

Interviewer - So you learned how to find out if it's a boy or a girl about the frogs. So, what else did you enjoy about learning about the frogs?

Elaine – I guess how to tell between different frogs because if it's a **Fowler's Toad** it has – uhm – it only has like three warts or more in its spots, but like some people confuse it with an **American Toad** and that one has like two or less in its spot.

When asked to describe the bioblitz field investigation, Betty shared a story of catching a Snapping Turtle in a turtle trap and how Mr. J held the animal and told them about it.

Betty– Mr. J picked up the **Snapping Turtle** and he showed us the bottom of it and how – their plastron is much smaller than a regular turtle, like a **Cooter**. And so they have really strong jaws and really long necks to compensate for the small shells that they have. (Exit interview, emphasis added)

When asked why she chose to take the photograph of the Eastern Newt upside down (see Figure 9),

Alicia – Dr. T was explaining to us how to determine the sex of the newt for our data collection. I wanted to capture a photograph of the underside, so I could remember how to tell it was a male newt – the black velcro on the legs, which he uses to grip the female. Then, I thought I could also use this photograph to teach others how to tell the sex of a newt, and once I got them interested in that I could

> explain more like where they live, how to hold it so they don't hurt it, and how we can protect ephemeral pools by not adding fish or draining the pools. (Photovoice focus group, 6/25/13)

Figure 9. *Photograph by Alicia Shared during First Photovoice Focus Group.*

The above excerpts show how participants were confident and comfortable sharing information they had learned during the Academy HRE. This provides further evidence of how the students' understanding of herpetology and practices of field ecologists had increased. When asked to provide additional explanation, Kamal, Patrick, and Elaine were all three able to explain specific natural history information about the herps they discussed. Betty was able to explain the morphological differences of snapping turtles from other turtle species. Alicia chose not to take a dorsal image of the Eastern Newt but felt it was more important to capture the ventral side, which she planned to use to remind herself of how to sex a newt as well to educate others about this characteristic of newts.

Examples of discussing scientific concepts and tools (emphasis added)

When asked to describe a time he felt he was doing science,

Patrick – We went to the mountains during the school year and did this set up called **tree cookies**, and it's just logs and they're placed in like moist areas along the mountain.

Interviewer – Like a whole long log?"

Patrick – No, they (park rangers) took a log and cut it, so you just had this, yeah, circle or wood cookie as they called it. They (tree cookies) were laid out and we just lifted up the cookie to see what was under there and if there were any salamanders there.

Interviewer – So, what was your data like? What did you find?"

Patrick – We found about how the tree cookies were set up in groups or **transects**, so there was group A, B, C, etc…There were ten cookies in each group. My group didn't really have very much but the other groups with us, they found like a wide variety of salamanders.

Interviewer – Did you get to see any of them (salamanders)?"

Patrick – Yeah, they found a **Red Eft**, so that was interesting because no other group had found that before us. (Exit interview)

When asked to describe a moment when he felt like he was learning,

Quincy – When we talked about frogs, I didn't know there was a difference between frogs and toads. They didn't really like the same habitat, but they do lay their eggs near water. And salamanders how they have to stay moist.

Interviewer – What was it about that moment you think will stick in your memory?"

Quincy – Before she (Dr. T) would let us hold the frogs and salamanders at the ephemeral pool, we had to make sure our hands were wet for the frogs or the salamanders. They really need a moist environment. And then when we came back to class I think it was like the next day, we learned about **desiccation**, so that's why we had to wet our hands. (Exit interview)

When asked to describe other moments when she felt like she was learning,

> Alicia – The biologist from the university taught me that it is good to have **controlled forest fires**, because you know you're taught by Smoky the Bear 'you're the only one that can prevent fires.' But controlled forest fires are good because it renews the forest. It keeps the – like the ticks and all the mosquitoes and stuff down to a low level. It also removes the leaves and underbrush. (Exit interview)

In these examples, Patrick discussed a research study he experienced three months prior to the Academy HRE, and he remembered vivid details of the set up and the discovery the group made. Quincy and Alicia provide examples of students learning scientific concepts (desiccation and controlled forest fires) and displaying an understanding of why these concepts are important.

Having and asking questions. Though identifying herps and discussing scientific concepts aided the participants' in understanding herpetology, the course did not always center on having answers. Rather, having and asking questions became a prominent component of the classroom culture and an indicator that the students' were developing their understanding of herpetology and the processes of inquiry. As Dr. T emphasized on the first day, "My goal for all of us is to develop and ask questions…questions that might not necessarily have answers yet. This is how science advances" (Field notes, 6/17/13). Tabitha, also discussed this during her exit interview when she was asked to compare the Academy HRE to school science, "Here it is discussing and being like **open to discussion**, and you can **ask any question** and not feel stupid" (Exit interview, emphasis added).

Tabitha's quote exemplifies how the participants did not feel that they were judged based on questions; instead, asking questions lead to learning. The participants also equated having and asking questions to being curious as the excerpt from Jaylyn's exit interview indicates.

> *When asked to explain why he chose to describe himself as curious during the Academy HRE,*
>
> Jaylyn – Because while we were on our hunt for all these different amphibians and reptiles and things, I really wanted to know more about them, why are they here?, what are they doing here?. What are types of environments they have to live in? What's the best way to hold one or carry one if you capture them in the wild?" (Exit interview)

Casey's exit interview excerpt also indicates how curiosity and question asking was linked to deepening one's understanding.

> *When asked who he would recommend to be SRAs next year,*
>
> Casey – Definitely Kimberly. She's like so excited about it. She loves the snakes. She learned a lot too. She learns really quick. She's very open minded with things and then she'll try new things all the time. She's **curious**.
>
> Another one, would probably be, well they're all good students, Jaylyn. He's quiet, but he's learned a lot. And he's **always asking questions** so I feel like he's very interested in what we're doing and understands the material. He feels for like the animals and their habitat destruction and he ask questions. (Exit interview, emphasis added)

As seen with these two examples, asking questions became a method of inquiry (e.g. Jaylyn asking questions about habitat) and demonstration of knowledge (e.g. Casey recognizing curiosity in Kimberly and Jaylyn as an indicator they had "learned a lot").

The following classroom vignette also stresses how students engaged in proposing questions during classroom discussions and used these questions to advance their thinking about herpetology and field ecology. During this classroom instruction, I was leading the classroom discussion and another educational researcher (Aerin) was videotaping and taking field notes.

> *Lizards are the topic of today's class. Lacey has a Green Anole cage in her hand, and each table has at least one Green Anole cage on it. The students have been instructed to observe the anoles and write down any observations they make in their notebooks. Lacey has given the students 10 minutes to complete this task. She places her Green Anole cage in front of Quincy and Patrick.*
>
> Lacey – Don't forget to also write down any questions that come to mind as you are observing. Questions are what lead to discoveries.
>
> *Discussion at Table 3* (see Table 4)
>
> Quincy – Did you see that? He blinked.
>
> *Patrick nods his head and moves the cage closer to him and Quincy. Patrick comments on how the anole is as high up on the stick in the cage as he can get. After making this observation to Quincy, Patrick proceeds to write in his notebook. Quincy also comments on the color of the anole and how it is browner than the other ones around the room. Patrick again writes in his notebook.*
>
> Patrick – Good point. Do you think it could be because the vegetation in our cage is more dead?
>
> Quincy – Dude, good thinking! Write that one down.
>
> *Patrick picks his pen back up and begins writing in his notebook again. Quincy has now started to write as well. The two boys continue to watch the anole until Lacey calls time.*
>
> *Once the 10 minutes has lapsed, Lacey asks for volunteers to share their observations. Several students share the color of the anole. Patrick shares his group's observation about the color of the anole and the background color.*

Students seem to like how the anoles can color change. Alicia asks if they can try putting the anoles on different backgrounds. Lacey explains that scientists have not yet determined why exactly anoles change colors though predation, territoriality displays, and stress are factors. Alicia then says they should record the color of any anoles they encounter on their field investigations, and Lacey says this is a great idea. She tells the students about a great article on Anole Annals, a website she had previously mentioned. Lacey wraps up the discussion by asking for one final observation.

Betty – We noticed our anole is clinging tightly to the stick.

Quincy – Yeah, we observed that too. Is your anole at the top of stick?

Lacey asks how many other groups noticed the anole was on the stick in the cage. The other two groups raise their hands.

Lacey – Interesting observation. Anyone think of a question to go along with this observation?

Patrick – We did. We wanted to know when the anole is not scouting out its territory if it prefers to spend time higher in the tree/brush. Would this position keep it safer from predators?

Lacey – Great questions, Patrick.

Casey – That makes me wonder about what type of predators the anole has, and if there are fewer tree dwelling predators. Our field guides didn't discuss that.

Betty – Yeah, I would think there should be less. Remember Mrs. Huffling said the green anole went higher into the tree…I can't remember the exact word she used.

Jaylyn – The canopy.

Betty – That's right, canopy. The greens go higher up in the canopy when the brown anoles invade, so I would guess there are fewer predators.

Barbara – Also, when you chase them, they tend to run up the tree.

Quincy – How high do they typically go?

Kimberly – Now I have a question. Do females spend the majority of their time at higher positions in the trees than males or are they same?

> Casey – Better yet. What do anoles spend the majority of their time doing? And where do they spend it? *Several scholars can be seen nodding their head.*
>
> *Lacey has allowed the participants to carry the discussion, and she is now ready to demonstrate to the class how to lasso a lizard.*
>
> Lacey – Now you have something to research during study time. You can go to the Anole Annals website, which as I told is run by scientists who study anoles. They have great summaries of research articles. We can also post any sightings we make on there. And who knows maybe you will find no one has answered your question yet. *After saying this, Lacey transitions into the lassoing demonstration.* (Field notes and video, 6/25/13)

As this classroom vignette shows, the students were beginning to better understand anole behavior as their questions developed. There was also evidence of them understanding the processes of field ecology as Alicia recommends a habitat experiment (changing the background of the cages the anoles were in) and data collection (recording color of anole) during field investigation. Thus, the more one learned, the more questions one had.

Using animals as study tools. Another aspect of participants' deepening understanding was how they used the animals as study tools. As Alicia said of her photograph of the newt (see Figure 9), she desired to take the photograph so she "could remember how to tell it was a male newt" (Photovoice focus group, 6/25/13). Several students (n = 11) took photographs of the animals to help them learn herpetological concepts throughout the course. The cameras provided for the photovoice project became an additional study tool used to capture photographs for study. For instance, participants using the cameras to capture photographs for study occurred during the class as the excerpt below describes.

> *There are at least two toad containers on each table. Dr. T has explained how to determine the sex of the toad, and it is now time for the participants to practice. Three of the groups (1, 2, and 4*; see Table 4*) have not yet opened their containers because they are waiting on someone to get out a camera. This started when Betty made an announcement to her group, which was loud enough for the whole class to hear.*
>
> Betty – Wait. I need to get out my camera so I can take pictures of the throats so I can learn this. *She hurriedly removes her camera from its case.*
>
> Alicia – Oh I want a photograph too. Here Betty you hold the frog first because you did it the other day, and I'll take the photograph with your camera. You can share it with all of us later. *Alicia slides the container over to Betty, while Betty hands her the camera.*
>
> *Groups 1 and 4 now have at least one person with camera in hand. It takes a few minutes for Group 3 as they opened the cages as soon as Dr. T said go. Quincy is the first to notice the camera flashes.*
>
> Quincy – Hey, that's a good idea. Patrick, grab your camera. We should document this so we can go back and remember how to do this.
>
> Patrick – Okay, I just finished writing it in my journal. Let me find my camera. This way we will have words and photos. (Field notes, 7/1/13)

Elaine also shared a photograph she took of a Green Anole during one of the photovoice focus group sessions to remember how to hold the organisms (see Figure 10).

> *Elaine shares her photograph with her focus group (Alicia, Betty, Gary, and Jaylyn). The other participants state they see a Green Anole, and they notice that it is under stress because of the color change. But they also discuss how the eyes are not blue, so it could be calming down. After the participants have shared their perspectives, Elaine explains why she chose to take the photo.*
>
> Elaine– I **wanted to remember** how to hold the anole, and I was also trying to capture the claws and scales **to remind me** about the characteristics of a reptile.
>
> Jaylyn – Yeah, this photograph would be great to use for **our own study**, and we can share it with others to show them how to properly hold a lizard. (Photovoice focus group, 7/1/13, emphasis added)

Figure 10. Photograph by Elaine Shared during Second Photovoice Focus Group.

The above excerpts highlight how the participants used the actual animals in the classroom as study tools. The vignettes below exemplify how the participants often talked to the organisms as they were observing them.

> *Two participants (Alicia and Betty) have arrived early to the classroom. They immediately head back to the anoles' cages. Betty picks one up and holds it close to her face. Alicia has put her face directly up to one as well, but she has chosen to hunch down to and leave it remaining in the lab container.*
>
> Alicia – Hey there, fella. Look at your little claws. That's one way to tell you are a reptile. *Alicia appears to be talking to the anole and not Betty. Betty does not respond but continues to look in her container.*
>
> Alicia – You are bright green today, so you must be happy and content. Did you know that you can't detach your jaw like a snake? This is how we can tell glass lizards from snakes. *Though Alicia still appears to be talking to the anole, Betty responds to her statement by talking to her anole.*
>
> Betty – She's right you know. *Betty appears to be addressing the anole in her container.* "You can't detach your jaw, but you can blink, which snakes can't do. So don't feel bad about the jaw thing." *Other participants are starting to enter the classroom and Dr. T moves toward the front of the room. Betty puts her container down and heads to her seat. Alicia continues to look in the cage.*

> Alicia – Okay, fella. Class is starting, but I sure am glad you can survive in captivity because I love having you in class. I wish your cousin the Six-lined Racerunner could live in captivity because I would love to see one, but I don't want it to die. Maybe we'll see one on a field trip. *Alicia turns and greets Gary's table* (see Table 4) *before heading to her seat.* (Field notes, 6/27/14)

Though Alicia and Betty both appear to talk to the anole, the conversation centers on them telling the anole about itself. Alicia distinguishes a characteristic of reptiles (claws) and she makes an inference about the color of the anole. She further distinguishes glass lizards (a legless group of lizards located in the state in which the study took place) from snakes, and Betty picks up on this and adds in another difference between snakes and lizards, which is lizards have eyelids and snakes do not. This type of learning happened often in the classroom and in the field.

> *Kamal is holding one of the pet corn snakes, and he is conversing with Tabitha about how smooth the skin felt when they ran their fingers down the body, but when they ran their fingers the opposite way, the skin is a little rough.*
>
> Kamal – That's right. You have slightly keeled scales. Smooth one way and a little rough on the flip side. *He appears to say this to the snake. Tabitha then leans toward the snake wrapped around Kamal's arm*
>
> Tabitha – It's okay to be a little rough around the edges. Kamal here is. *Kamal laughs at Tabitha's comment.*
>
> Kamal – Yeah, that's probably why I like reptiles so well. They have rough edges unlike the 'slimy' amphibians that have no scales. (Field notes, 7/8/13)

In the above example, Kamal demonstrates his understanding of keeled scales (scales that have a ridge down the center which makes them more rough), and Tabitha uses the knowledge to joke with him. Kamal also indicates his dislike of amphibians but combines this again with the knowledge that amphibians, unlike reptiles, are scaleless.

While on the bioblitz at Casey's house, my group (Casey, Alicia, Mary, Kadence, and Gary) is walking through the woods toward the edge of Casey's property for us to start our survey. Casey is the assigned leader, and he stops suddenly to pick up a toad.

Casey – Hey look you're a male. *This comment is directed to the toad in Casey's hand.*

Alicia – Let us see. *The group gathers around Casey.*

Kadence – How can you tell it's a male again?

Casey – See. Look under his chin. *He says to the whole group.* "Hold on there, buddy. I need to flip you over to show off that handsome dark color. *Again, this comment is directed to the toad.*

Mary – Oh, Casey is right. You do have a nice dark color. *Mary is talking down to toad.*

Alicia – The ladies must love you. *Alicia also appears to be talking to the toad. Gary has quietly walked away and comes back to the group with another toad in his hands.*

Gary – I don't know if she is attracted to color. *Comment is directed toward Alicia.*

Gary – You need to hear him sing, don't you? *He says this to the toad as he lifts up his hand for Alicia to see.*

Alicia – That's right. Mr. J did say mating calls attracted females.

Kadence – Let me see her. *Gary passes the female toad to Kadence.*

Kadence – Look at you. Your throat is all cream like milk. *Comment is directed to the toad in her hand.* Do ya'll see her lack of color? *Question is directed to the group of students.*

Casey – Oh here, let's hold them side-by-side.

Casey and Kadence stand together and hold the frogs while Gary, Alicia, and Mary look at them. Mary takes out her camera and snaps a photograph of the toads for the group.

Alicia – Are they the same type of toads? *This question is directed toward me.*

Lacey – I think this is a great time to get out those field guides.

Mary and Gary get out their field guides, and the group determines the toads are American Toads.

Gary – Are these on the list? *Referring to the list of herps that are still needed for voucher specimens for the county, he directs this question to Casey.*

Casey pulls the folded list from his back pocket and scans it.

Casey – Nope. We don't need these. Looks like we can let you go, fella.

The students release the toads and we continue walking to the property line. (Field notes, 7/2/13).

In the above vignette, the group comes together to use the animals to learn how to determine the difference between a male and a female toad (males have darker throats). Gary also uses the animals to add information to Alicia's statement about females loving the color of the male's throat by commenting to the female toad that she would need to hear the male toad call. This group study session is instigated and led by the students, which is evidence not only of the students' understanding but also of them beginning to feel able to facilitate their own learning, which exemplifies principle b of CEA.

Summary: Principle a. Tabitha's exit interview emphasizes the three aspects of learning that emerged as enabling students to deepen their understanding of herpetology and the practices of field ecology.

When discussing when she felt like she was learning,

Tabitha – Here (the Academy HRE) you learn 20 times more by being so hands on and **asking questions** while you're actually holding an animal, like a **Green Anole** and like **pointing it out and showing us different body parts** and stuff like that. So you learn a lot more. (Exit interview, emphasis added).

As emphasized in the above quote, Tabitha discusses how learning occurred while asking questions. She gives an example of a herp (Green Anole) found in the area, and she describes how the animal could be used as a hands-on study tool to point out and show the different characteristics used to classify and identify the organism.

The post-survey administered at the end of the HRE also provides support for the themes that emerged for principle a. After the themes were established from the qualitative data, I reviewed the post-survey instrument (see Appendix H) and coded the questions that mostly closely aligned with principle a. Four questions were coded (see Table 7). The results provide evidence that participants were aware of their deepening knowledge of herpetology and its practices (see Table 7).

The class average for all four coded post-survey questions was above 4.0, which indicates the participants had a high view of the knowledge and understanding they acquired. Also, none of the students rated themselves below a 3, which also demonstrates that they believed they had deepened their understanding. Elaine, who had the lowest view of her science abilities on the pre-survey (see Table 4), had high views of her understanding on the post-survey, rating herself at 4 or higher for each question. There were no significant relationships between the averages for principle a and ethnicity, gender, or grades. The results speak highly to the participants' perception of their deepened understanding during the month-long course.

Table 7

Post-survey Results for Principle A

	To what degree did participating in this HRE increase your…[a]			To what degree did participating in this HRE make you feel…[a]	
Participant	**Knowledge of science**	**Ability to use tools**	**Understanding threats that amphibians and reptiles face**	**More curious about nature**	**Average**
Alicia	4	5	5	5	4.75
Barbara	4	4	4	5	4.25
Betty	5	5	5	5	5
Casey	3	5	5	5	4.5
Elaine	5	4	5	4	4.5
Gary	3	4	4	4	3.75
Jasmine	5	4	4	4	4.25
Jaylyn	5	3	5	5	4.5
Kadence	4	3	3	5	3.75
Kamal	4	4	4	4	4
Kimberly	3	5	3	5	4
Mary	5	5	4	5	4.75
Patrick	3	4	5	4	4
Quincy	3	3	5	5	4
Tabitha	5	5	5	5	5
Class Average	**4.07**	**4.2**	**4.33**	**4.67**	**4.33**

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (to a great degree).

Participants' ability to deepen their understanding of herpetology and the practices of field ecology was important to enabling their CEA, as understanding is necessary for participants' to recognize themselves as experts. Bowen and Roth (2007) discuss how as field ecologists experience prolonged exposure to their field sites their observations become more salient and they begin to ask more specific questions and identify more variables within the system of study; thus, generating learning through having and asking questions enabled participants to engage in another practice of field ecology. Alagona and Simon (2010) also found that immersion in fieldwork fostered greater scientific curiosity in university students, which was observed in the Academy HRE. Using the animals as study tools gives credence to Lock's (1994) and Strgar's (2007) assertion that living organisms are essential to learning biology, and it also supports findings that have demonstrated that students learn better when exposed to live materials (G. W. Scott et al., 2012; Taraban, McKenney, Peffley, & Applegarth, 2004).

Calabrese Barton and Tan (2010) emphasize the importance of a knowledge base for students in order that they might exhibit agency with and in science, which "implies that students use the knowledge, practice, and context of science to develop their identities, to advance their positions in the world, and/or to alter the world towards what they envision as more just" (p.195). Academy HRE participants were able to exhibit this type of agency as will be discussed in the section on principle e. In addition to using their knowledge base to exhibit CEA, deepened understanding of the organisms also contributed to participants' understanding of place, as participants made connections to what types of environments would be good habitat for herps.

Principle B

Identify themselves as experts in one or more realms associated with EE (such as environmental sciences, economics, and political sciences)

Participants identified themselves as experts in various aspects of herpetology. For instance, Quincy declared his expertise of salamanders during the exit interview, "Because I knew, I had a **background of salamanders** and I was able to learn more about them that day (ephemeral pool investigation). So I **felt confident** about talking about salamanders, because I **knew a lot about them**" (Exit interview, emphasis added). Kimberly also recognized her expertise with snakes as she described how she helped a fellow participant learn to hold a snake.

> *When asked about a moment during the HRE that made her feel proud of herself,*
>
> Kimberly – I convinced one of the girls, who like was really afraid of snakes, to hold a snake. And it was really cool, because she was like so dead set the first week, saying 'I'm not touching snake, don't get me near a snake.' By the end like I had convinced her it's okay. It's just a snake.
>
> Interviewer – Did you already have experience with snakes?"
>
> Kimberly – Yeah, I used to have a pet snake, and I've read a lot about them. (Exit interview)

Eleven initial codes emerged for principal b, which were then sorted and collapsed into three salient themes (see Figure 11).

"No one else did it." One way that participants indicated their expertise was recognizing that no one else accomplished what they had achieved. Whether it was learning to use a new scientific tool, such as a lizard lasso, or finding and capturing a herp, participants were quick to point out such instances in their exit interviews.

> *When asked about a time she felt particularly good about herself,*
>
> Tabitha – I would say like with the lizard lassos, **I got it the first try** and **nobody in our group did** (groups 1 and 4 were combined for this activity; see Table 4), so I felt pretty on top and it was really fun because I didn't think lizard lassos were even real. So it was fun to actually find a new way to catch a lizard instead of chasing it around and scaring it.

Interviewer – Great, now why did you feel particularly good about yourself with that?

Tabitha – Maybe because Amy (one of the international students who did not participate in this study) didn't get it the first time and I did. (Exit interview)

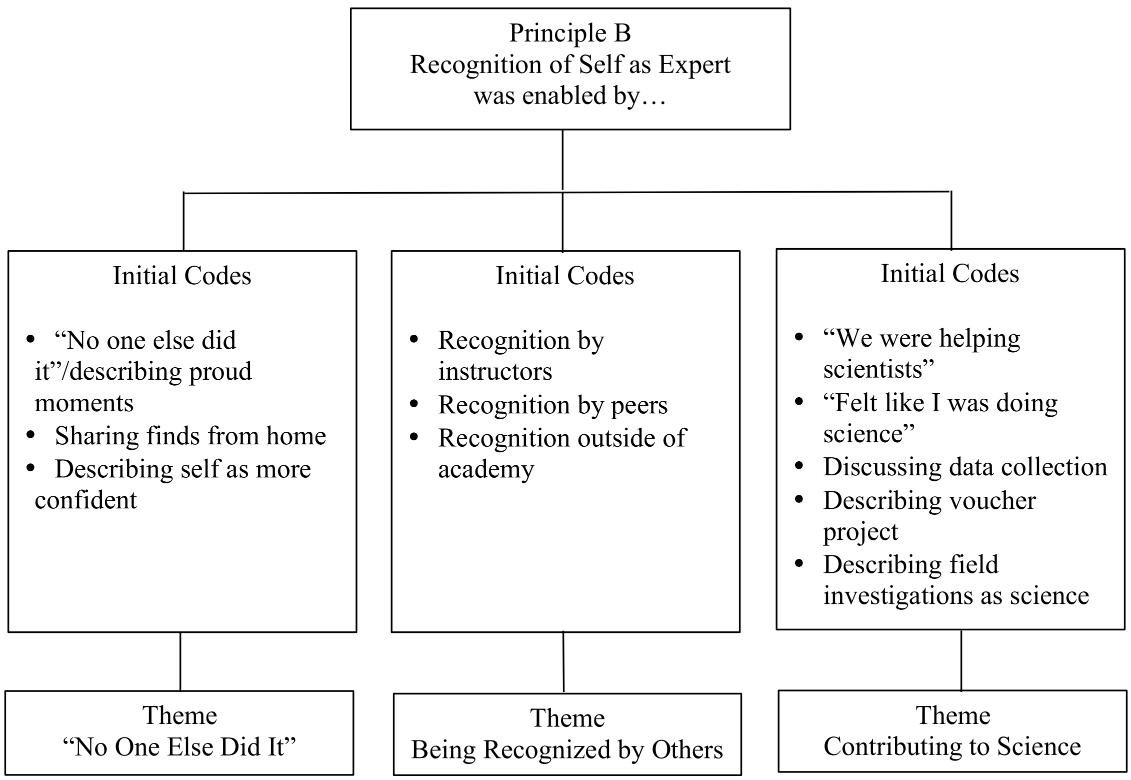

Figure 11. Themes for Principle B.

As Tabitha indicates in her exit interview, she was proud to be the first to figure out how to use the lizard lasso. In fact, she quickly became the group expert and was called on by other participants to help them when it was their turn (Field notes, 6/25/13).

Andy's answer below to the same exit interview question also shows how expertise was used to assist others.

> Andy - When we went to the University Forest and we were flipping over logs and stuff, I was catching the millipedes and I was showing everybody. I felt pretty good because it was something **no one else did**. Nobody wanted to touch them.
>
> Interviewer – So why did that make you feel good?
>
> Andy – Hmm…because I was helping other people feel comfortable, instead of like putting them in their face and going, here take it. (Exit Interview)

In the above example, Andy discusses the field expertise he had in knowing how to find, identify, and capture millipedes, and it made him feel good to share his expertise with the others.

Jaylyn and Patrick also experienced a moment of pride when they describe how they were able to find and capture a frog.

> Jaylyn – We went to the University Forest to find anything we could find. We were like lifting up logs and everything and moving everything and I spotted a frog. It was an American Toad and **no one could see it**. So I picked it up and showed it to everyone. It was **the only one** we found. (Exit interview)

> Patrick – Well, we took a trip to University Forest to visit the Ephemeral Pools. They usually dry out this time of year, but we've had like a really wet summer so they're still there. We weren't really finding a lot, so I was kind of disappointed, so we went down to the largest pool. It was a lot smaller than it was naturally, because it was in the summer, but **I found the only frog**, I think, that we found the whole trip, so that was good. I had to look really hard to find it. (Exit interview)

What is interesting in the above examples is that Jaylyn and Patrick are recalling the same experience, the trip to University Forest. Both remember their frogs and how they were difficult to find. Finding organisms requires developing a search image, a skill field ecologists must nurture to find the organisms they are seeking. Yet, both state that they were the only one to find a frog, which seemed strange to me. However, after I re-examined the field note data, I realized their claims of being the only one to capture a frog were true. The class was split into two groups, and Jaylyn and Patrick were in different groups. Due to the limited amount of time for this field investigation, the two groups did not share their finds in the field. They did debrief the following Monday, which was the next day of class, and both Patrick and Jaylyn shared their stories but the expertise they demonstrated in their individual groups seems to have stuck more in their memory than their shared stories.

Alicia used her prior experiences with dissection in the health sciences classes to become an expert when the participants dissected snakes. Elaine, her partner, watched as Alicia performed the dissection. As the dissection progressed, other participants (Andy, Casey, Gary, and Kimberly) came over to watch Alicia cut open the stomach before they attempted the same. Alicia used the dissection as an example of how she loves science, especially the health sciences.

> Alicia – We dissected a snake, oh my God that was scary to begin with because it was snake, but then, I focused in. I cut out the liver and I was looking at it. And **when I cut the stomach people came to watch**– ours had a baby bird and you could tell it was a bird, because you could see the beak, you could feel it, you could see the wings and the tail feathers. But like **nobody else could tell**, so I was like it's a baby bird. And it had a piece of a fish, which stunk really bad. (Exit interview, emphasis added)

Though this theme of being the only one to do it was abundant in the exit interviews, it was not as prominent in the field notes or the photovoice focus group data. This could be because of the emphasis the Academy places on learning in community, so participants adapt a more inclusive language and do not focus on their individual accomplishments as much. However, this theme does demonstrate how participants viewed themselves and how they were willing to tell others (e.g. the educational researchers conducting the exit interviews) about their individual achievements.

Being recognized by others. Others also recognized participants as having expertise. Jaylyn's response during the exit interview also highlights how this aspect of recognition affected him, "**Dr. T said 'Oh, good job**,' **every time I caught** something, and no one has ever said good job on really anything that I actually really tried to do. So, I did something good, and **my friends were cheering me on**" (Exit interview, emphasis added). As Jaylyn stated, Dr. T almost always followed up a participant's capture in the field with a comment on how great they did and how they handled/captured the animal like a pro, as the vignette below shows.

> *During the field investigation at University Forest, Jaylyn has been hesitant to go into the woods. He appears to be uncomfortable in the field. Suddenly he drops to his knees and his hands are cupped. Dr. T sees his action as well and comes running.*
>
> Dr. T– Jaylyn, what do you have?
>
> Jaylyn – It's some kind of frog. I'm trying to trap its back legs.
>
> *Jaylyn brings up the frog in his hand with the back legs pinned like Dr. T had shown them previously in the classroom.*
>
> Dr. T – Wow! Look at that **expertise** in holding that frog. *Calls out to the other participants in the woods.* Everyone over here. We have our first find. *The other participants come over.*
>
> Andy – Man, I walked right by here. How'd you see that?

> Jaylyn – I concentrated on just looking down and watching for the ground to move.
>
> Betty – You're like a young Steve Irwin.
>
> Dr. T – Look at how Jaylyn is **developing his search image**. Way to go!
>
> *Dr. T puts up her hand for a high five and Jaylyn bumps her with his elbow because he is holding the frog. He is smiling really big. Dr. T begins a discussion on how to tell what type of toad it is by having students use their field guides.* (Field notes, 6/28/13; emphasis added)

The above example also shows how Betty and Andy recognize Jaylyn's skill in finding the frog. Andy mentions he had just walked past that spot and didn't find anything, so he wants to know what Jaylyn did. Betty also recognizes Jaylyn's expertise as she compares him to Steve Irwin, who is famous for tracking and capturing animals. Participants also recognized each other's expertise in working with organisms, as with Alicia's skill to handle lizards which is shown in the vignette below.

> *The students have been placed in three groups and are ready to try their hand at lizard lassoing. Betty confidently steps up to try first. She is successful at capturing the lizard with a lasso, but she cannot get the lizard off the stick and it is turning brown. Alicia comes up to help her. Alicia gently grabs the lizard.*
>
> Jaylyn – Look. The lizard is turning back green. Alicia, you're like the dog whisperer but instead of dogs its lizard. *Alicia's smile widens and she holds up the lizard for the others to see.*
>
> *Quincy steps up to try lassoing the next lizard. After he has captured his lizard, he turns to Alicia and asks her to show him how to hold it. The next three participants (Jaylyn, Elaine, and Patrick) follow suit. Alicia has established herself and has been recognized by her peers as the expert in the room.* (Field notes, 6/25/13)

Alicia also referred to this recognition in her exit interview, as she discussed being recognized by others as an expert in holding lizards.

> *When asked to describe herself during the Academy HRE,*
>
> Alicia – **The other participants called me the lizard whisperer**. Because when somebody else would hold them (Green Anoles), they (Green Anoles) would get stressed and their eyes would turn blue. And when I would hold them, they would calm down and if they were camouflaged, they would go back to green. (Exit interview, emphasis added)

Though recognition, like that highlighted above, happened often within the Academy HRE, participants also shared instances where their growing expertise was recognized outside the Academy HRE.

> Casey – One of my friends, during the school year, saw a snake and I looked at it and I'm like oh, that's just a black snake. I didn't even have to like go up to it. I could just see it from the characteristics I saw. (Exit interview)

> Barbara – My science class at school took a field trip to the beach, and we found a frog. And my science teacher was so astounded because I could identify it and give the scientific name of the frog. It's not just at the Academy that this experience has affected me but also in my every day life and in school. (Exit interview)

During their exit interview, Casey and Barbara both shared instances where they were recognized for their herp expertise. Kimberly shared a similar story with me one morning before class began.

> *Kimberly arrived early to class today, and she was anxious to show me photographs of a Worm Snake she and a friend found on a local hiking trail. As she put the camera in my hands, she began to tell me about how impressed her friend was that she could identify the Worm Snake.*

> Kimberly – So I made sure to bring my field guide just in case we found something, and it must have been my lucky charm because we ran across that little guy right on the trail. As soon as I saw it though, I recognized it was a worm snake. In fact, my friend thought it was a worm and was surprised when I said "Hey, look a Worm Snake." He was like no way. Then, when I picked it up and showed it to him. He said "Dude, how did you know?" I told him all about the herp class, and he said he couldn't wait to tell all our friends that we have a new herp expert in the group, which made me feel really good.
>
> *I told her that the photographs were excellent and her story was exciting. At this point she told me that it took a little while to capture the photographs. However, it was another opportunity for her expertise to shine.*
>
> Kimberly – My friend was also impressed with how I took my time taking the photos, so I got to tell him about photovoice. He said I was in charge of taking our prom photos this year and I could even bring a snake if I wanted. When we got home, he told mom and she told me she was proud to have an expert in the house. (Field notes, 7/8/13)

Jaylyn's story about his favorite photograph of the second week of the photovoice project (see Figure 12) also highlights how participants were being recognized as experts outside the Academy HRE.

Figure 12. Photograph by Jaylyn Shared during Third Photovoice Focus Group.

Jaylyn is holding his photograph of Leopard Geckos for everyone to see.

> Jaylyn – I choose to use this photograph this week because I went shopping with my family, and my siblings begged me to take them to the pet store, while my mom shopped. My mom told me to take them and teach them about reptiles and amphibians in the store since I was now the family expert, so I took a picture of me and my family could remember the experience. (Photovoice focus group, 7/10/13)

As demonstrated by the above examples, recognition from others enabled participants to assume an expert role during the Academy, which lead to the further development of their CEA.

Contributing to science. Being able to contribute to larger science projects, such as providing voucher specimens for the state's Museum of Natural History or collecting data for The HERP Project, also afforded participants expertise status, as it appeared to legitimize the fieldwork they were doing. For instance, when asked to describe how he felt about the voucher project, Patrick said, "It really makes you feel like we are **contributing to something bigger** because they were going to take our data and look at it and **I was actually helping**" (Exit interview, emphasis added).

Given that the exit interviews provided opportunities for participants to reflect upon their experiences, this theme was mostly developed from that data source, as shown in the following excerpts. There were instances captured in the field notes and the photovoice assignments that supported this theme of contributing to science.

When asked about why the bioblitz was her favorite experience in the Academy HRE,

> Alicia – We used traps like scientists do. They (scientists) have mechanisms that help them go out into the world and like discover things. This is what scientists

do, and we did the same thing. We were able to catch things and report our findings on the herp database. (Exit interview)

As Alicia's statement shows, she recognized that the field investigations were not only similar to what scientists do, but their data were made available to the general public through the Carolina Herp Atlas, a citizen science database developed for people to report herp sightings in the Carolinas.

In responding to when he felt like he was doing science, Casey's reflection also highlights how the students placed emphasis on the authenticity of their experiences in the Academy HRE.

Asked to share a story about when he felt like he was doing science, Casey discussed the ephemeral pool investigation at Dr. M's house.

Casey – When we went to the ephemeral pool, we pulled out the minnow traps and we netted the water for salamanders. And then we had our little waterproof field guides with us and we wrote down what we found and how many of what we found. Then, we weighed and measured them. Our data got put into the Android to upload so Dr. M would have it because she's been studying her pool for years. It makes me excited to know that **I'm doing something that actually is helping other scientists**. (Exit interview, emphasis added)

A discussion captured at the ephemeral pool between Quincy and another participant, who was not part of this dissertation study, echoes Casey's sentiment.

Dr. T has allowed the participants to pick their partners at the ephemeral pool, though she does distinguish Barbara, Casey, Elaine, Quincy, Patrick, and Tabitha as leaders because of their prior experience. The leaders are not allowed to pair together. Quincy and another study have teamed up. As I am observing the pair, Quincy tells his partner,

Quincy – I'll do the first trap and you can do the next. *Quincy opens the trap and is excited to find a newt.*

> Quincy – Dude, we are doing science now! Okay get out the notebook and Android. We've got to be careful with our data because we're helping scientists here.
>
> *Quincy and his partner begin to process the newt. After they are finished, they fist bump and move onto the next trap.* (Field notes, 6/20/13)

Andy and Kimberly also discussed the ephemeral pool as the time when they felt the most "sciency" in the Academy HRE.

> *Asked to share a story about when he felt like he was doing science, Andy too discussed the ephemeral pool investigation at Dr. M's house.*
>
> Andy – Well, we were catching salamanders, larvae, and tadpoles. I felt like a scientist because I was going out and **doing field research** and **we were the ones taking a survey of the animals for the owner** (Dr. M). (Exit interview, emphasis added)
>
> Kimberly– When we went on our field trip to a vernal pool, we were using the HERP project app to record actual data that we were getting from the salamanders we were finding. So that showed me like hey this is – this is actual science. **We're helping like people do research here** and I think that was the first time that I felt like oh, it's science. I felt like it was **– it was helping educate us** and us to help educate other people. (Exit interview)

Andy highlights how the group was doing field research and Casey connects the data collection to the ongoing survey of the pool that Dr. M does. Kimberly's quote demonstrates how contributing to science was also helping the participants to learn, and she goes even further by connecting their learning through helping scientists to how this would also help them educate others, which will be discussed further in the section on principle e.

Mary's quote below shows how the connection to a larger project, like the voucher specimen project, gave the experiences a larger purpose than just going in the woods to look for herps.

> *When asked how she felt about the voucher project,*
>
> Mary – It (the voucher project) made it so that it (field investigations) was more than just, oh, cool we're just going to go try and catch some frogs. **There was a reason for us doing this and learning how to identify the animals**. (Exit interview)

Participants also discussed this aspect of the Academy HRE, as they recognized how photographs could be used to further contribute to research being conducted in the HERP Project. For instance, Betty's description below of how her group used their camera to take pictures during the bioblitz.

> *Dr. T starts the class today by asking the participants to share their group's finds from the bioblitz, which happened the day before. She gives them a few minutes to gather in their groups. The participants pull out their field notebooks and discuss who will speak for their group. Betty volunteers for her group (Quincy, Kimberly, and two students not in the study). Her group agrees. Dr. T calls the participants back, and Betty volunteers to go first. She has her camera out and passes it to the group behind her.*
>
> Betty – My group really wanted to share the huge Bullfrog we found. We had left the containers on the porch, and we really wanted to show the class. So we decided to take photos of it to show everyone today. The camera is being passed around. We had to hold it (Bullfrog) and take pictures of the top and the bottom and the sides of it. And that way, **we had even more evidence** to present with our recorded data.
>
> *Betty continues listing her groups' finds as the camera is passed from person to person.* (Field notes, 7/3/13, emphasis added)

As Betty indicated, the photograph became an extra datum source for her group and a way to enhance their contribution to the bioblitz project. Barbara, Kimberly, and Mary had a similar discussion in regards to their photovoice photographs for week 3. All three had found herps at their house over the weekend, and though they were not in the same focus group, they talked about their photographs before class.

> *As participants are entering the classroom, Barbara, Kimberly, and Mary have their cameras out and are exchanging them with each other.*
>
> Kimberly – Wow, your photo of the salamander is great! *Comment said to Barbara.*
>
> Barbara – Thanks. I think it is so cool you both saw lizards and were able to photograph them. They move too fast for me. *Mary shakes her head in agreement.*
>
> Mary – I know what you mean I was so afraid it was going to run away. I'm surprised my mom screaming for me to come outside didn't scare it off. *They all three laugh.*
>
> Barbara – Don't forget to create accounts on the Herp Atlas because we need to upload our photos there. I created one last year and uploaded times my family and I found herps. My brother was like "we be contributing to real science." It was fun.
>
> Mary – We should also start an Instagram hashtag of real science.
>
> Kimberly – I love it! (Field notes, 7/10/13)

As the above conversation demonstrates, connecting their learning to science enabled participants to see themselves and other class members as people who were able to contribute to and conduct ecological investigations.

Summary: Principle b. Recognizing and establishing themselves as an expert in one of the realms of EE is important for the continued development of students' CEA because it documents their deepened understanding of herpetology and the practices of field ecology (principle a) while also enabling students' to participate in identity development (principle e). Since I am using a sociocultural view of identity, it was important to establish how participants recognized themselves as experts and how other recognized the participants' expertise (Gee, 2001), which is supported by the themes: *"No one else did it"* and *Being recognized by others*. The final theme of *Contributing to science* demonstrates how participants were provided opportunities to use their developing expertise outside the classroom.

The post-survey also provides evidence for the students' budding expertise. First, I analyzed the same post-survey questions, as I did in Chapter 3 for the pre-survey, to develop the participants' self-reported science ability/interest score (see Table 8).

In comparing results from the pre-survey to the post-survey, nine out of 16 participants indicated that participating in the Academy HRE had increased their science ability/interest from the pre-survey ratings. The six participants who did not show an increase rated themselves the same on both the pre- and post-surveys. Tabitha had the greatest gain at 1.8 points, with Kimberly having the second highest gain at 0.8 points. The two SRAs (Barbara and Casey) along with Betty rated themselves as 5 on both instruments. Like on the pre-survey, Elaine rated herself as 1 for *I think I could be a good scientist* and *I think like a scientist*. The overall class average did increase significantly ($Z = -2.692$; $p < .05$), and there were no significant differences between ethnicity, gender, or grades for the gain scores.

Table 8

Pre/Post-survey Results for Self-reported Rating of Science Ability/Interest

Participant	Pre-survey score[a]	Post-survey score[a]	Gain score
Alicia	4.2	4.8	0.6
Barbara	5	5	0
Betty	5	5	0
Casey	5	5	0
Gary	4	4	0
Elaine	2.8	2.8	0
Jasmine	3.6	3.8	0.2
Jaylyn	4.2	4.8	0.6
Kadence	3.8	3.8	0
Kimberly	3.4	4.2	0.8
Kamal	3.4	3.6	0.2
Mary	3.6	3.8	0.2
Patrick	4	4.4	0.4
Quincy	3.4	3.6	0.2
Tabitha	3	4.8	1.8
Class Average	**3.89**	**4.23**	**0.34***

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (very likely).
* $p < .05$

Next, I coded the post-survey questions and found four questions that aligned with principle b. The results provide evidence that participants' did see themselves as people who could do and contribute to science (see Table 9).

Like the post-survey results for principle a, the class average for all four post-survey questions was above 4.0. Elaine was the only participant to rate herself below a three, which was for *feeling like a science person*. Ethnicity, gender, and school grades did not yield any significant relationships with principle b scores. However, it seemed contradictory that Barbara, Casey, and Betty gave themselves a 3 for feeling that they *could be good at science or a related field* since they rated themselves a 5 on their science ability/interest on both the pre/post-surveys. All but two participants (Kamal and Quincy) rated themselves at 4 or above for feeling like it were possible for them *to contribute to science*.

Table 9

Post-survey Results for Principle B

	To what degree did participating in this HRE increase your…[a]	To what degree did participating in this HRE make you feel…[a]		To what degree did participating in this HRE make you feel like it is possible for you to…[a]	
Participant	**Confidence in doing science**	**Like a science person**	**That you could be good at science or a related field**	**Contribute to science**	**Average**
Alicia	5	5	5	5	5
Barbara	5	5	3	5	4.5
Betty	5	5	3	5	4.5
Casey	5	5	3	5	4.5
Elaine	4	2	3	5	3.5
Gary	3	3	5	4	3.75
Jasmine	4	4	3	4	3.75
Jaylyn	4	5	5	5	4.75
Kadence	4	5	5	5	4.75
Kamal	4	4	3	3	4
Kimberly	4	4	4	5	4.25
Mary	3	3	3	4	3.25
Patrick	3	4	5	4	4
Quincy	3	5	3	3	3.5
Tabitha	5	4	5	4	4.5
Class Average	**4.07**	**4.2**	**4.0**	**4.4**	**4.17**

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (to a great degree).

As evidenced by the data, each participant had at least one moment where they were able to author themselves as an expert in herpetology. Being able to exhibit one's expertise is critical for students, as it shapes their identity development providing opportunities for students to view themselves as people who can do and contribute to science (Tan et al., 2012). This performance aspect of identity development has been shown to be important for science identity development (Brickhouse et al., 2000; Calabrese-Barton et al., 2008; Carlone & Johnson, 2007) and most recently has been applied to environmental identity development (Stapleton, 2015).

It is also important to note that participants were recognized for more than extensive content knowledge; expertise was also defined as being able to find and capture specimens. Carlone et al. (in press) also documented a broadened idea of what and who counts as smart (or expert) when they studied the 2012 HREs. This broad concept of expertise contributed to a more equitable environment, which afforded students more instances to be seen by themselves and by others as having expertise to share.

Principle C

Gain a deep understanding of place, leading to a critical consciousness of place

During the Academy HRE, participants were provided with opportunities to explore their own community as previously discussed in research question one. They also were encouraged to spend time in their own backyards through the photovoice project. Time spent in nature afforded participants opportunities to further their understanding of the place in which they lived. In fact, Alicia actually indicated on her pre-survey that she took the course to be out in nature and learn about her community.

Gary's quote from his exit interview also shows how participants developed their critical consciousness of place.

> *When asked if he noticed anything about his environment that he had not noticed before the Academy HRE,*
>
> Gary – **I had never seen or heard of an ephemeral pool** before this class, so I **never noticed** that like when it does a lot of raining, it makes little ones on the sides of the roads. And you can see the frogs jumping in there. **They have figured out how to live with us, and we need to do the same.** (Ext interview, emphasis added)

As Gary's statement illustrates, he noticed puddles on roadsides that had always been there, but he now sees them as habitat for animals but he takes this further by adding that frogs have figured out how to live with us. The frogs take advantage of drainways that humans have developed, but Gary also advocates that this learning to coexist needs to be reciprocated by humans (reinhabitation; Greenwood, 2012). Seeing their environments and communities in new ways contributed greatly to the participants' critical consciousness of place.

As I continued to analyze my qualitative data, 15 initial codes emerged. I then sorted and collapsed them into three salient themes for this principle (see Figure 13). In the sections below, I present evidence for and discuss each theme.

Using the environment as a lens. Part of developing a critical consciousness of place is learning to use the environment to see in a new ways by focusing one's attention on minute details that were before overlooked or hidden. This new perspective allows one to narrow or widen her scope of view when immersed in nature (Gruenewald, 2003).

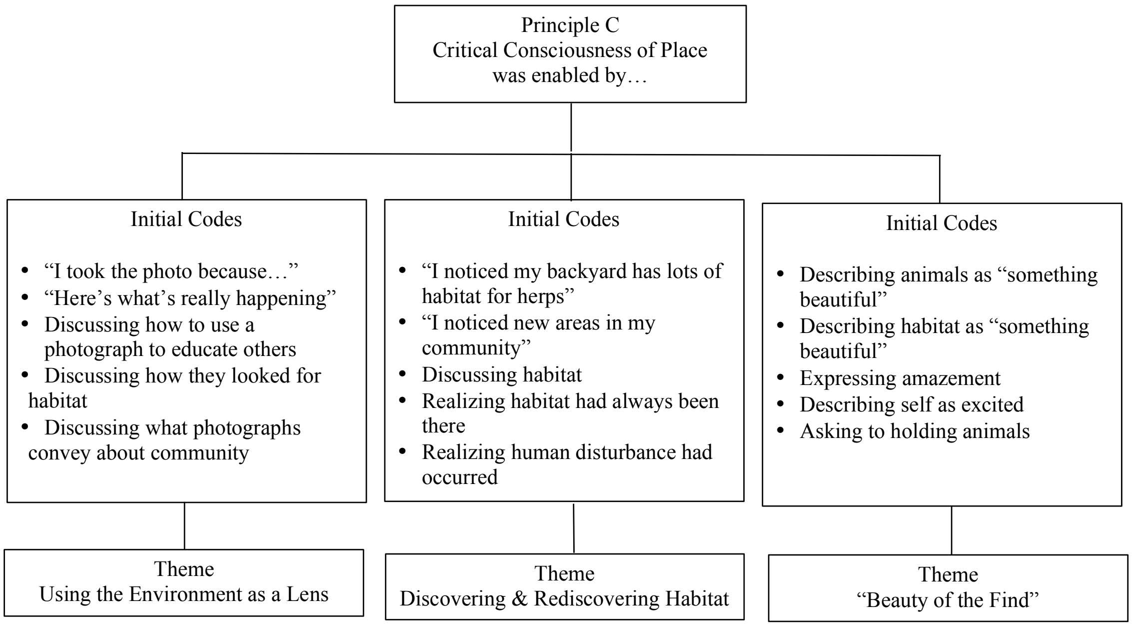

Figure 13. Themes for Principle C.

Participants in the Academy HRE learned how to use the environment as a lens when searching for habitat and herps, as the examples below show.

> *When answering if he notices anything in this environment that he didn't notice before the Academy HRE,*
>
> Patrick – Just when we go out, identify plants and trees, and so like now after going to this class, I can just look in my backyard and I can see where herps will live. Or, like on a rainy day and there's like a puddle on the side of the road, I'm looking and thinking how herps could be there. I'm just **more aware anytime I'm just walking around anywhere**. I have a **better understanding of where the animals live and how to preserve that area**. (Exit interview, emphasis added)

Patrick's statement exemplifies how the participants began using their time in nature to better understand the animals they studied in class.

Alicia's comment to another participant about a small ephemeral pool found on the University Forest field investigation also shows this, "There's so much **variety in this pool** and it's not even here all year long" (Field notes, 6/28/13). Through this statement, Alicia is starting to see how the environment can change even when life is present at the moment. Mary also mentioned in her exit interview how on the field investigations, "**We are out in their** (herps) **habitat. We didn't bring them into ours this time**. (Exit interview, emphasis added)

Mary's unforgettable moments came as she experienced being in the habitat, and she further distinguishes looking for herps in their habitat versus seeing them in her habitat (the classroom). Jaylyn describes such a moment as a time when he was truly learning about the animals and/or their habitats.

> *When asked why he choose the bioblitz as the time when he felt he was truly learning,*
>
> Jaylyn – It really **opened up to me** where certain animals will live and move to mate, like how some frogs live in trees and come down to mate. It really **showed me** why they live in certain places. (Exit interview, emphasis added)

Andy, like Jaylyn, began to think differently about nature as he participated in the photovoice project, "It (taking photographs) let us **view the world** from **a different point of view**. (Exit interview, emphasis added). Thus, participants also developed their ability to use nature to develop a new viewpoint through the use of cameras when they had to determine how to capture the photograph, which included what to capture and what to exclude in order to focus their audience's attention on what they were attempting to capture with their photograph.

> *In describing the photovoice project,*
>
> Jasmine – I learned the different places animals could be living. Like I learned that, the little puddles on the sidewalk that **I pass all the time** – that could be habitat. (Exit interview, emphasis added)
>
> Quincy – I thought it (taking photos) got us **thinking about habitats and observing the environment.** What it made us think about it (the environment) and how we interpreted it. See, there's like a little creek behind my house. So I went to it to take pictures one day, and I saw tadpoles in it, so I liked that. **I didn't know there were tadpoles** in there even though I'd been to the creek before. (Exit interview, emphasis added)
>
> Tabitha – I was like oh, this is going to be hard because you know you got to take photos and then you've got to explain them in-depth. And you have to find them meaningful, and I was like how am I going to take a meaningful photo about a herp or its habitat. But once like you get your camera and you go outside and you're just like looking around and actually **paying attention to nature** and like the details of every river or puddle. You find things **are already meaningful**.
>
> One of my pictures was a pool, a little type ephemeral pool, in the back of my friend's house and there was a tire track going through it (see Figure 14). For me, it showed how humans can create habitat but also disturb it. It shows how human's aren't fully aware of their actions. (Exit interview, emphasis added)

As the above examples indicate, participants began to focus in and pay attention to their environment, which was different than how they viewed it before as Quincy discovering tadpoles in the stream for the first time though they had more than likely always been there. In giving an example to further explain how the photovoice project aided her in seeing nature as meaningful, Tabitha demonstrates how she is beginning to consider human interactions in regards to places where animals dwell.

Figure 14. Photograph by Tabitha Shared during Second Photovoice Focus Group.

Several participants also shared during focus group sessions how they took their photographs to narrow the focus of the audience, as shown below.

> *Kamal is sharing his photograph* (see Figure 15) *with his group (Casey, Barbara, and two participants who are not part of this study), and he begins to explain why he framed his photograph the way he did.*

Figure 15. First Photograph by Kamal Shared during First Photovoice Focus Group.

> Kamal – All you see is this hawk eating a squirrel, **what you don't see is how close it is to human society**. And how dangerous that could be for the hawk. The

animals were here first and then we came in and expanded our territory. I wanted to **capture that feeling**. Then, I zoomed out to try to put into context for people not familiar with the University. I want to display the first photo and then have people see the second one.

Kamal holds up another photograph (see Figure 16) *for the group to see.* (Photovoice focus group, 6/25/13, emphasis added)

Figure 16. Second Photograph by Kamal Shared during First Photovoice Focus Group.

Kamal purposefully zoomed in on the hawk eating as to focus his audience's attention on the hawk. Then, he took a zoomed out photograph to emphasis how this happened on campus. Tabitha used a similar technique in her photograph taken to discuss ephemeral pools near her property (See Figure 17).

Tabitha has quietly listened as the members in her group (Kadence, Quincy, Gary, and Patrick) have discussed what they see in her photo. While they were saying things like trees, a field, a truck, and a building, Tabitha was smiling. It seems her photograph might hold a few secrets.

Tabitha – Well, you have noticed what is in the photograph, but I took this photograph because in front of those trees at the back of photograph are small pools that get much deeper when it rains.

Kadence – But we can't even see the puddles.

Tabitha – I know. My point was to show **what we miss when we don't explore** our environment. If you only looked from our driveway and never crossed through the field, you would not know they (the puddles) are there. It is a really good place for frogs to lay their eggs, and the trees in this picture are providing shade for the pools. The government is actually thinking of cutting down these trees to build houses, and **this affects me** because it would change our land by drying up our pools.

Quincy – Wow. There is a whole backstory to the photograph. I would have never known that without your explanation.

Tabitha – That's why I'm glad we will write captions for our photos because I can take a photograph like this and **explain it's meaning to me**. (Photovoice focus group, 7/10/13, emphasis added)

Figure 17. Photograph by Tabitha Shared during Third Photovoice Focus Group.

Kamal and Tabitha both provide examples of participants beginning to understand how to see the environment as a means of emphasizing human involvement, which is needed for a critical consciousness of place. Their examples also provide a segue into the next theme that emerged, as participants began to discover and rediscover habitat.

Discovering and rediscovering habitat. Discovering habitat was one way participants deepened their understanding of place, and often times, the students realized that they were not actually discovering new habitat but rather seeing nature in a new way, so more of a rediscovery. Patrick's reflection below demonstrates this process of discovering and rediscovering habitat.

> *When asked if he noticed anything about his community that he hadn't notice before the Academy HRE,*
>
> Patrick – Well in my backyard **I didn't realize**, because I don't really see very many herps in my backyard, but **I have a lot of good habitat places**. And I started **paying attention to more of the environment** in the new shopping area, and how that **would have been a really good place for herps**. But, we've built on and into it. But I did notice, like right behind all the malls, there's a huge pond. So, I was just thinking, if we went down there, we could probably find a lot of reptiles and amphibians. (Exit interview, emphasis added)

Patrick's quote exemplifies how he discovered habitat in his backyard and how he discovered where habitat once was in his community, but then he rediscovered possible habitat as he realized there was a retention pond behind the outdoor shopping mall and this could be possible habitat.

Like Patrick, participants consistently discussed how they discovered habitat at their homes and in their communities.

> *When asked if they noticed anything new in their environment since being part of the Academy HRE*
>
> Gary – I **never noticed** that when it does a lot of raining, it will make small pools in ruts on the side of the road. And you can see the frogs jumping in there. I go down the road from my house and look to see what I can find after it rains. (Exit interview, emphasis added)
>
> Andy – I **never realized** how many possible places there are for herps to hide. I used to go around the woods and like push logs over for fun, but I **really never noticed** I was destroying something's habitat. (Exit interview, emphasis added)

> Kimberly – I **didn't realize** how many herps were around my house. I didn't realize how many lizards were around the house, and if I went to our pond that there were salamanders in there. I **never really thought** about it before because I'd just go fishing and not think of everything else that could live there. Like my uncle, he just like filled in a little pool he had because there were mosquitoes and he didn't like it. So he filled it in and I **now realize** how that ruined a habitat for a lot of animals that breed in there. (Exit interview, emphasis added)

As the participants' excerpts show, they were beginning to reflect on the discoveries they made during the Academy HRE and how they were rediscovering habitat. Gary began to discover potential frog habitat, while Andy began to understand he disturbed habitat when he randomly knocked logs over in the woods. Kimberly discovered habitat around her house, and she realized how her uncle's actions lead to the destruction of potential habitat.

Kimberly also emphasized the habitat around her house, when she used her photograph of a Fence Lizard (see Figure 18) in one of the photovoice assignments.

> *Dr. T and I decided the students needed some practice writing captions to help them continue to reflect upon their photographs, which also tied into the Academy's emphasis on writing in the discipline. So, at the beginning of class, Dr. T instructs the students to take out their class notebooks and remove a sheet of paper. As participants are doing this, I begin to pass out the photograph(s) they chose to share in their focus groups. Dr. T explains that the participants need to develop a caption for their photograph.*
>
> Dr. T – The caption should quickly capture what you were thinking when you took the photo. The paragraph that will accompany the caption will go into detail, so don't worry about trying to capture all your thinking in a few words.
>
> *Participants begin to study their photographs. Kimberly catches my eye and waves me over.*
>
> Kimberly – Will you read my caption?

Lacey – Sure. *I pick up Kimberly's paper and read her caption: Adapting to human areas.* That's a great caption. How did you think of it?

Kimberly – I've noticed that the fence lizards really like our house and garage. It seems they've made a human structure their home, which I think is important to let people know. Organisms can adapt as long as we allow them and don't kill them.

Lacey – Oh that is excellent. Make sure you capture that in your paragraph.

Kimberly smiles and starts writing her paragraph.

As Kimberly continues to write, Dr. T lets the participants know they have a couple of minutes left before she will collect their work.

Dr. T – Don't worry if it's not perfect. This is practice. Think of it as free writing where you are trying to capture your thoughts. We just want to see how you're thinking.

After a couple of minutes, Dr. T and I collected the photographs with the papers. (Field notes, 6/24/13)

Figure 18. Photograph by Kimberly Used during Photovoice Writing Assignment.

Jasmine also reflected on her discovery of habitat during the photovoice writing assignment (see Figure 7 for photograph).

Jasmine – The caption for my photograph is 'Leaves can provide a home.' This is a picture of a grassy area with leaves. The grassy area is potential habitat where you find herps. They could be moving throughout the debris or hiding under the leaves for shade or protection. All the grass is an ordinary sight to us, we have to be aware of the creatures that live there. We could be a threat to the herps in the grass if we aren't careful; however, we also have the potential to benefit them in a good way as this habitat exists in a man-made environment. (Photovoice writing assignment, 6/24/13)

As Jasmine and Kimberly's assignments demonstrate, the participants were discovering and rediscovering habitat in their everyday lives. They learned to see through the eyes of the herps and to find potential habitats throughout their community.

"Beauty of the find." Participants made connections to the herps and the places they are found through their various interactions with animals in the classroom and in the field. This theme developed from Patrick's explanation of why finding herps during the field investigation was an unforgettable moment for him. "Just like **the feeling** you get every time **you find something**, you know **sort of beautiful**" (Exit interview, emphasis added). Other participants also discussed the beauty they experienced in finding herps.

When asked to tell a story about his favorite learning experience, Jaylyn described when he and Kadence pulled in their first minnow trap.

Jaylyn – It was this little metamorphosis frog and it had this big body and then like the legs, it had full long legs but it still had the long tail. It was awesome, and I remember thinking how **it was beautiful**. (Exit interview, emphasis added)

When asked to describe why he liked the salamanders at the ephemeral pool,

Andy – I guess the way they walk. I mean, I don't really know how to describe it, but it's just **unique and amazing**. And then I always heard about newts but I've never really held one and seen one in real life, so that felt pretty cool.

> *When asked to explain why the ephemeral pool field investigation was a "wow" moment for her, Kadence explained how she felt when she opened the minnow trap to find a tadpole.*
>
> Kadence – So I was like what in the world, it's a tadpole with legs. And I thought **that was amazing**, because I was like **it's so pretty. Nature is beautiful**.

Jaylyn and Kadence both shared their excitement and amazement at finding a metamorph tadpole. Even though they did not hear each other's interview, they both described the find as beautiful. Andy also was amazed at seeing a newt walk, and he was excited because he had heard about them previously. Experiences like these were important, and it is interesting that all three participants highlighted the ephemeral pool field trip, which was the first field investigation where they found herps. Alicia, Kimberly, Kamal, Betty, and Mary also described finds from this experience during their exit interviews, and each one described the herps as cute, amazing, or beautiful.

Beauty also became a theme during the photovoice project, as participants used the "beauty of find" as a way to introduce others to herps and to educate them about the organisms.

> *Quincy explains to his group (Gary, Patrick, and Tabitha) why he chose to take the photograph of the frog on his finger* (see Figure 19) *and not on the ground.*
>
> Quincy – I was with my friends, just hanging out when I spotted something small moving on the ground. As I got closer and closer, I found it was a tiny frog. I was really surprised at how small it was. I picked it up to show my friends how exciting it is to find herps and **how cute and fragile** they can be. I took this photo to show that humans should be more aware of their surroundings or we will miss the little things. (Photovoice focus group, 7/3/13)

Figure 19. Photograph by Quincy Shared during Second Photovoice Focus Group.

Quincy desired to show his friends the beauty of nature by having them see the tiny toadlet up close. Mary and Kimberly also discuss the “beauty of find,” as they look at her skink photograph in their photovoice focus group (see Figure 20).

> *Mary has shared her photograph of a skink* (see Figure 20)*, and the participants are discussing the question of how Mary could use the photograph to educate others.*
>
> Kimberly – The photograph could be used to show others **the beauty**. How finding something is fun but then **you realize how beautiful it is** when you take time to really look.
>
> Mary – My mom said almost the same thing when I showed her the photograph on my camera. She commented on how she never realized how pretty skinks could be. (Photovoice focus group, 7/3/13)

Figure 20. Photograph by Mary Shared during Second Photovoice Focus Group.

Summary: Principle c. As students began spending more time in nature and learned more about herpetology, they began to deepen their understanding of place, which led to developing a critical consciousness of place. The caption for Elaine's photograph in Figure 21, "The beauty and fragileness of nature," demonstrates how participants began to perceive their environment.

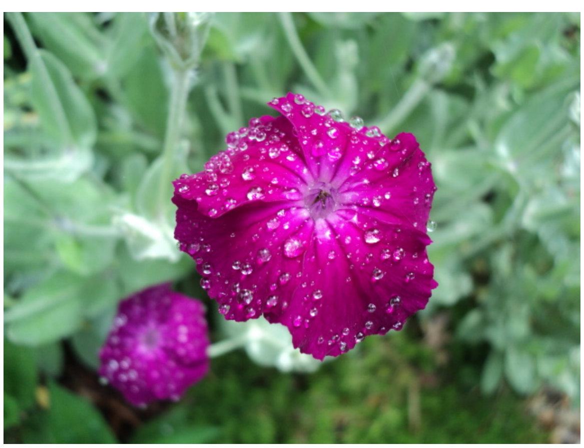

Figure 21. Photograph by Elaine Used during Photovoice Writing Assignment.

In explaining her caption, Elaine wrote “I was amazed at how beautiful the flower looked with the water droplet, but then it hit me that the rain had actually pushed the flower petal down. It was so fragile, which can remind people how fragile our environment is” (Photovoice writing assignment, 6/24/13).

The responses to three questions on the post-survey also support the participants’ deepened understanding of place. The results provide evidence that participants’ believed the Academy HRE affected their understanding of place (see Table 10).

Similar to the post-survey results for principles a and b, the class average for the three post-survey questions used as indicators for principle c was above 4.0 and none of the students rated themselves below a 3.0. Though no significant relationship was found for ethnicity or grades, females had significantly higher ratings than males ($Z = -2.083$; $p < .05$) on principle c. In addition, all nine of the females selected a score of 5 to indicate how much their *empathy for animals* had increased, which is interesting given that scholars have proposed that developing a “feeling for the organism” is one of the attributes of field ecology that is most attractive to females (Bowen & Roth, 2007; Korfiatis & Tunnicliffe, 2012). All participants selected 4 or 5 for feeling *connected to living things in their environment*, which is a strong indicator for critical consciousness of place (Greenwood, 2012). Once I discovered females had significantly higher averages for principle c than males, I re-examined my qualitative data but found that frequency counts were similar for both males and females.

Table 10

Post-survey Results for Principle C

	To what degree did participating in this HRE increase your…[a]		To what degree did participating in this HRE make you feel…[a]	
Participant	**Empathy for animals**	**Connection to nature**	**Connected to living things in your environment**	**Average**
Alicia	5	5	5	5
Barbara	5	4	4	4.33
Betty	5	5	5	5
Casey	3	4	5	4
Elaine	5	5	4	4.67
Gary	3	4	4	3.67
Jasmine	5	5	4	4.67
Jaylyn	4	3	5	4
Kadence	5	3	5	4.33
Kamal	5	5	5	5
Kimberly	5	4	4	4.33
Mary	5	5	5	5
Patrick	5	4	4	4.33
Quincy	4	4	5	4.33
Tabitha	5	5	5	5
Class Average	**4.6**	**4.33**	**4.67**	**4.51**

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (to a great degree).

Deepening one's understanding of place is essential for CEA in that place accounts for the cultural, biological, ecological, and physical components of the place (Lutts, 1985). As Golley (1998) states, "the landscape is a text that informs us about its capacity to produce and support life, its history, and what organisms are likely to be present" (p. ix). Thus, participants learning to use the environment as a lens supported their reading of the environment as text, which several scholars have argued is fundamental for environmental literacy development (Chambers & Radbourne, 2015;

Stables, 1996, 1998; Stables & Bishop, 2001; Stables & Scott, 1999). Making these connections to place can also develop comprehension skills, which are "required in order to be able to visualize, infer, synthesize, and question, especially at a deeper level" (Chambers & Radbourne, 2015).

Furthermore Gruenewald (2003) asserts, centralizing place within a curriculum enables students to analyze how economic, political, and personal decisions impact local spaces. This, in turn, can led to a critical consciousness of place, where students learn to "(a) identify, recover, and create material spaces and places that teach us how to live well in our total environments (reinhabitation); and (b) identify and change ways of thinking that injure and exploit other people and places (decolonization)" (p. 9).

As evidenced in the three themes, participants deepened their understanding and began developing a critical consciousness of place as they used the environment to frame their thinking, discovered and rediscovered habitats in their local communities, and concentrated on the beauty and fragility of nature. Similar findings of deepening and broadening understanding of place and self were also reported by Alagona and Simon (2010) and Casey Allen (2013) in their study of university students' engagement in fieldwork. Thus, participants were able to connect to their environment and developed an ability to use the environment as a way to discern places where herps could live and how humans have encroached into these places, which further enabled their CEA.

Principle D

Strengthen sense of place and demonstrate behaviors, actions, and/or individual and/or collective agency to consider, discuss and/or act on environmental issues

As the participants deepened their understanding of place, their sense of place was also strengthened, which afforded participants opportunities to consider, discuss and demonstrate agency in regards to environmental concerns they had. However before participants could engage in strengthening their sense of place, they often had to work through or forget the discomfort they experienced when they conducted fieldwork. Participants worked through their discomfort together as they encouraged each other throughout the month-long course. Participants also chose to share their experiences with friends and family, which provided opportunities for them to discuss what they were learning in class and to highlight their growing sense of place. Alicia's description of herself during the Academy HRE shows how these themes worked together.

> *When asked to describe herself during the Academy HRE,*
>
> Alicia – *Excited*, because I really wanted to hold the amphibians and retiles after I got over my fear. I was **really uncomfortable** at first but then I just **forget about it** as the **others encouraged me** and I **spent more time in nature** with the animals. And then I would say *adventurous*, because I – I actually went out looking for frogs and stuff and trying to catch them. Instead of staying back like I did in the past when I was with my family. Now, I'm **telling them** (my family) about this and how I'm ready to go. (Exit interview, emphasis added)

Alicia admitted to the fear/discomfort she felt as she began the course, but with the help of her peers and opportunities to engage, she worked through it and became *excited* and *adventurous*. She even saw her family experiences changing as she strengthened her sense of place. Thus participants' sense of place developed throughout the Academy HRE.

During my initial qualitative data analysis, nine initial codes emerged. I then sorted and collapsed them into three salient themes (see Figure 22). In the sections below, I present evidence for and discuss each theme.

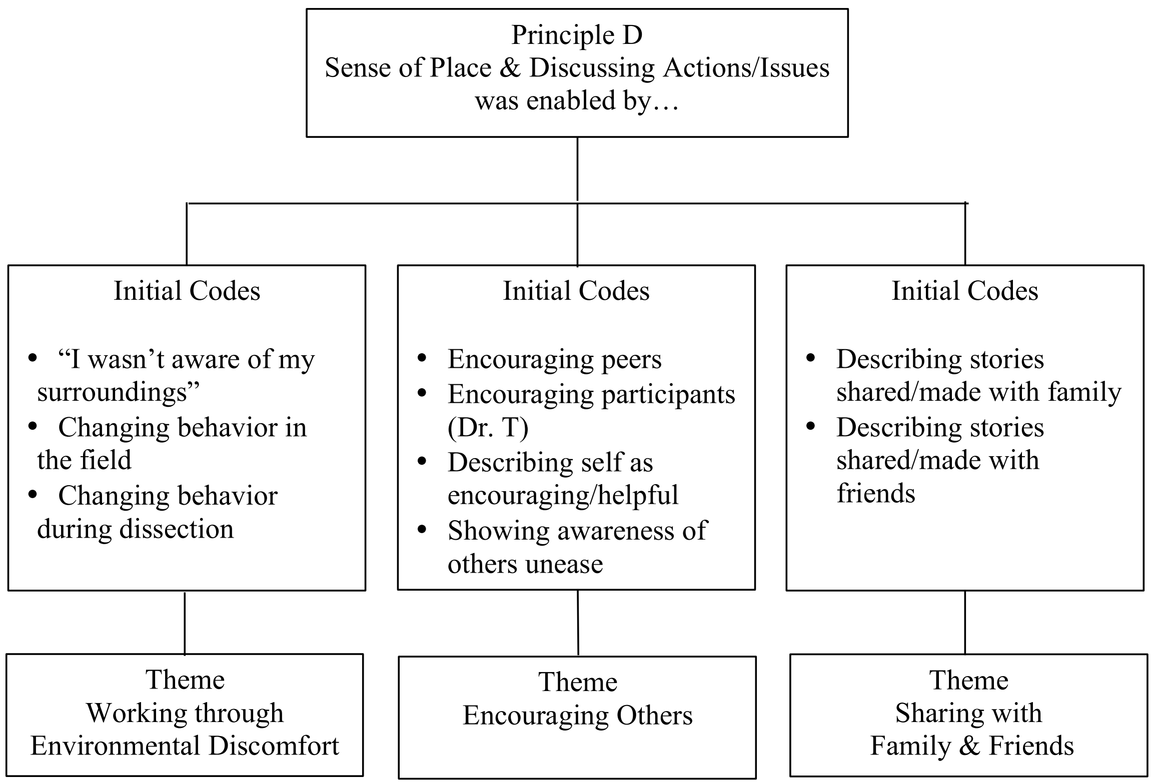

Figure 22. Themes for Principle D.

Working through environmental discomfort. In order to fully experience the field investigations and classroom activities, participants had to forget and/or work through discomfort. Ten out of sixteen participants mentioned at least one time when they had to work through either discomfort with the animals or with the environment. For instance, Jaylyn described how he forgot his discomfort in the woods once he caught a frog.

When asked to describe a moment when he felt particularly good about himself,

Jaylyn – I wasn't really looking around, because **I did not like the woods**. I just don't like all the bugs and stuff. I was being bitten and I was scratching. Then, I saw a frog. I **really didn't think about the woods** when I caught it.

Interviewer – Did it make you forget about the woods for a minute?"

Jaylyn – Yeah, **I wasn't really aware of my surroundings** after this, I just remember I caught a frog. (Exit interview, emphasis added)

Jaylyn was not the only one who worked through discomfort during the University Forest investigation, as demonstrated in the vignette below.

Everyone has arrived at the forest, and Dr. T has split the large group into two smaller groups. I decide to go with the forest group first. Andy, Alicia, Betty, Elaine, Gary, Kadence, Kimberly, and Jaylyn are part of this group. Andy, Betty, Gary, and Kimberly make a beeline for the woods. They are focused on searching for herps. Andy and Gary are carefully rolling over logs while Kimberly and Betty look for herps, where the log used to lay. When they find nothing, the boys put the log back where they found it. Alicia, Elaine, Kadence, and Jaylyn have to be encouraged by Dr. T before they begin to step into the woods. They are very hesitant, carefully looking before taking a step. Alicia has her arms in front of her, waving them wildly. I ask her what she is doing.

Alicia – Knocking down spider webs. I hate running into spider webs. *She shutters as she says this.*

Jaylyn – That's why I'm following you. *Says this to Alicia. Elaine and Kadence are behind Jaylyn.*

Andy approaches the small group with something in his head.

Andy – Hey look guys what I found. *He opens his hand to show them a millipede.* Dr. T showed me if I shake it, that it releases a gas that smells like almonds. Here smell my hand.

Alicia steps forward.

Alicia – Oh my gosh it does. Here smell.

> *She grabs Andy and moves him toward the others. The others smell his hand. Alicia follows Andy further into the woods. Her arms are no longer in front of her face moving rapidly. Rather, she is intently looking on the ground. It seems she has started looking for herps, forgetting her earlier fear of spiders. Kadence and Jaylyn also begin searching. Elaine is the last one to start looking, and as I leave to go see what the other group is doing Elaine rolls over her first log.* (Field notes, 6/28/13)

Jasmine, like Jaylyn, Alicia, Elaine and Kadence, also had to work through her discomfort in the field as it started to rain during the bioblitz field experience.

> *When asked to describe the bioblitz,*
>
> Jasmine – It rained really hard, and **I remember feeling cold and wanting to go inside** but then it was good and **I forgot it was raining** because I found like a bunch of different frogs and we found a snapping turtle and centipedes and millipedes. (Exit interview)

Jasmine had to work through her discomfort of being wet and cold in the field, but as soon as she started finding organisms she forgot about her discomfort. Betty, Gary Mary, Quincy, and Tabitha also mentioned the rain during the bioblitz, but like Jasmine they concentrated more on their finds than on how they felt about the rain. In addition to the rain, Tabitha also had to work through her fear of snakes.

> *When asked to describe a time when she felt particularly proud of herself,*
>
> Tabitha – I guess, the fact that we were actually hunting for snakes and **at the time I was like terrified of snakes**. I had the snake hook, why did I take the snake hook? But I thought well I have it and **all of sudden** I was so ready to catch a snake even though it started raining. (Exit interview, emphasis added)

Andy, Jasmine, Kimberly, and Kamal had to work through discomfort when they engaged in the snake dissection because of their affections for snakes (Field notes, various dates).

> *When asked to describe why the dissection was a moment they would never forget,*
>
> Jasmine – I mean at first I was kind of like, **this snake was alive** and I didn't feel like cutting it open but I soon realized well, I have to do this. Then once I got into it, I **forget about that**. (Exit interview, emphasis added)
>
> Andy – Actually, like handling the snake and looking at the actual animal and its parts and dissecting them (the body parts) out. I liked it when we dissected a snake, even though I love snakes and **at first it made me sad and I didn't want to do it**. (Exit interview, emphasis added)

> *Dr. T has finished passing out the snake specimens for dissection. I notice Kamal is just staring at his snake. I walk over to Kamal's table and ask him if everything is okay.*
>
> Kamal – This is hard. I feel like I'm dissecting my pet.
>
> *Kimberly overhears this statement.*
>
> Kimberly – I feel the same way. I don't know if I can do this.
>
> Lacey – I understand how you feel. I felt the same way every time I had to dissect cats with my anatomy students.
>
> Kamal – Do you have cats?
>
> Lacey – Yes.
>
> Kamal – So how did you do it?
>
> Lacey – Well, I tried to push it to the back of mind, and once we got started, the excitement and amazement of my students made me forget.
>
> Kamal – I'll try that, but I'm not convinced.
>
> *Kamal picks up the scalpel and begins to cut the snake. Kimberly follows suit.*

> Kamal – I can't believe how tough this is. Oh, I think I see the stomach.
>
> *From that point forward, Kamal and Kimberly are completed engaged. Neither of them mentions their pet snakes. Before the end of class, I go back over to Kamal's table.*
>
> Lacey – Well, what did you think? Are you glad you did it?
>
> Kamal – Oh yeah. That was awesome. It made me better appreciate how they are able to move and eat. But I was scared I was going to find a frog in the stomach. (Field notes, 7/9/13)

As the examples from Alicia and Kamal highlight, sometimes working through discomfort was aided by others encouraging participants during the process.

Encouraging others. Encouragement from others often enabled the students to work through discomfort, which allowed them to strengthen their sense of place by fully participating in the activities and interacting with the organisms. Tabitha's description of why students should consider taking the Academy HRE, exemplifies this theme.

> *When asked what she would say to students considering the Academy HRE,*
>
> Tabitha – Everybody here is comfortable around each other. And even though some people are still **scared of snakes and frogs**, we're here to **encourage them**. And **it's encouragement that they need to be able to step forward** and hold animals and be comfortable enough with themselves to hold the animals even if they are scared. And **we're here to help them break down those barriers** on their own time. (Exit interview, emphasis added)

Similar to Tabitha, other participants also described how they encouraged and helped their peers.

> *When asked to describe themselves during the Academy HRE,*
>
> Quincy – And **I helped other people overcome their fears**. Like the international student, he was afraid of anything and everything. But now he loves it – he's still a little squirmy, but it's all right because **we encourage him**. And then, my friend Kamal, he picked up a frog, but he said when he was little when he was laying down and a frog jumped in his mouth so he did not like frogs. But when we went to the bio blitz, he picked one up. So **that was good and I told him**. (Exit interview, emphasis added)
>
> Jasmine – I would describe myself as encouraging. I **helped and encouraged people**. If they're scared or something, I just encouraged them to do it. (Exit interview, emphasis added)

Not only did participants describe how they encouraged others, but participants who had to work through fear or discomfort also reported how the encouragement of their peers and instructors helped them.

> *When describing a moment where she was proud of herself,*
>
> Alicia – I think it was when I held the snake. **Because I had a bunch of my peers encouraging me to hold the snake.** And I grabbed the smallest one, a Smooth Earth Snake, although I touched the bigger snakes. (Exit interview, emphasis added)
>
> *When asked why students should consider the Academy HRE,*
>
> Kadence – They will actually like **congratulate you** when you step out of your comfort zone. Like when I held the snake, Dr. T was like I'm so proud of you Kadence. I'm proud like – you don't understand. That made me feel so good, because just from where I came from. It's a different environment here. It's really good. Like **everyone makes you feel good about yourself here even if you're scared**. (Exit interview, emphasis added)

Participants also encouraged each other during the photovoice focus groups. One example comes from the photograph Jasmine took of leaves on grass (see Figure 7).

> *Jasmine is sharing her photograph with her group (Andy, Kimberly, and Mary).*
>
> Jasmine – Well, my photograph is of leaves and how this can provide a habitat for herps or serve as protection for them.
>
> Kimberly – Did you get on the ground to take the photo? Because it looks like you did.
>
> Jasmine – I set the camera on the ground.
>
> Kimberly – It’s cool because it’s not from the top so it looks like it is not only possible habitat but it is from the animal’s perspective, so it lets us ‘see’ through their eyes, from their point of view.
>
> Jasmine – Thanks, I was nervous about showing it to ya’ll because it is only a photo of leaves. But I was trying to capture it as close as I could to show why we might want to leave some leaves in yards for habitat because it could provide shade and protection. (Focus group, 6/25/13)

Jasmine admits to being nervous about sharing her photograph, but as her peers encourage her, she reveals more about her thought process as she took the photograph. Encouraging others became a way for participants to aid their peers and contributed to their discussions about the environment as encouragement made participants feel more comfortable about sharing their points of view.

Sharing with friends and family. The final theme that emerged centered on instances of participants sharing their experiences with people outside the Academy HRE. Many of the experiences participants shared with their family and friends led to the participants sharing their knowledge of herpetology.

> *In describing how they took photographs for the photovoice project at their house,*
>
> Alicia – And so my mom always tells my dad to kill any snake that comes into our garden or she’s not going to go back out to the garden. Then the weekend that

> I went home, **my dad found a snake**. **I was like don't kill it**. I was like just put it back because there's like a forest behind our backyard. And **then he was like, okay,** but he didn't want me to take a picture of it because we didn't tell my mom so she would go back to her garden. (Exit interview, emphasis added)

> Betty – Well, I was taking pictures at home and **I was showing my mom and my sister who is six**, so she will grow up and learn about these things herself. But I was showing her pictures of the snakes and the frogs that we had in class. And the salamanders and all the stuff that we were finding. **I was explaining to them** what to do with them if you find them (herps). Or how to if it's a snake you can walk away from it. It's not going to chase after you.
>
> And **I was showing my dad** this is a corn snake and this is a black snake. You don't have to kill it. It's not venomous. And there's no such thing as a garden snake. A garden snake is just a snake that you find in your garden. It could be a rat snake or an earth snake or something like that. And every time my mom sees a snake she always thinks I have to kill it because it's poisonous. So I had to explain to them the difference between a venomous snake and a non-venomous snake. My dad said he'd try not to kill any more snakes. (Exit interview, emphasis added)

In sharing with their families, both Alicia and Betty discussed how snakes should not be killed, though that was how their families had handled snakes in the past. By using their individual agency, the girls were able to openly discuss the problem with their family and come to a new course of action to save the snakes.

Academy HRE experiences were also shared with friends. For instance, Casey describes how he surveyed his friends and found that they do not spend time in nature. He shared with them about what he did in the Academy HRE and now they want him to take them herping.

> *When asked if he would recommend the Academy HRE to his friends,*
>
> Casey – Oh, definitely –I have a bunch of friends that want to go into science. I talked to them to see what they do over the summers and what they do in their

> free time. And none of them have ever even experienced anything like this and they don't spend time in nature. After I told them about here, they asked me to take them out in the woods. (Exit interview)

Kamal also shared his experience and expertise with members of his church when an anole showed up on the church building.

> *When asked if he noticed anything about his community he had not noticed before the Academy HRE,*
>
> Kamal – Well, when I went to church this past Sunday, I noticed that people were looking at a Green Anole. They were more afraid of it than what they needed to be. So I just picked it up and told them how I was studying lizards this summer. After I showed it to them, I took it back to the forest behind our church and I invited a couple of my friends to go with me so that they could experience being in the woods like I had. (Exit interview)

Like Kamal, participants also strengthened their sense of place as they went into or enacted with nature with their families. Jaylyn, Kimberly, and Mary specifically discussed how they took photographs for their photovoice assignments while they were out with families.

> *Jaylyn shares with his group (Alicia, Betty, and Elaine) about why he took the photograph and how it shows a community strength* (see Figure 23).
>
> Jaylyn – My dad and I went to North park. We were looking down at the stream, and my dad explained how the area use to be filled with trash and how the government came and cleaned it up. Now there is community pride to keep it clean. It's the only nice natural area around so we want to keep it clean that is why this shows a strength in our community. That's why I took the photograph from looking down over the bridge. (Photovoice focus group, 6/25/13)

Figure 23. Photograph by Jaylyn Shared during First Photovoice Focus Group.

In his third focus group, Jaylyn shared the Leopard Gecko photograph (Figure 12) that captured another experience with his family. As discussed previously, Jaylyn took his siblings to the pet store while his mom was grocery shopping. He told his brother and sister stories about lizards that he had learned at the Academy, and then he taught them to look for claws and scales to distinguish the reptiles from the amphibians. They also looked at snakes and observed how they did not have eyelids, which is one way to tell the difference between a snake and a glass lizard (Photovoice focus group, 7/3/13).

Mary, like Jamal, also spent time in nature with her family. She shared during her focus group how she went with her mom to the creek behind her grandfather's house to find herps.

> *Mary explains to her group (Andy, Kimberly, and Jasmine) how she was able to get the photograph of the skink* (see Figure 20).
>
> Mary – It's actually a funny story. My mom and I we spent an hour outside at the creek behind my grandfather' house looking for herps. My mom took a shovel with her in case we ran into a snake, so I started sharing with her about how snakes help control rodent populations, which can bring disease. We found

> nothing but holes in the ground, which I told my mom could be something's home. After we went home, I was inside the house and, my mom started calling for me to come outside because there was a skink right on a log in our yard, so I got the picture. I loved this photo because I got to share with my mom. (7/3/13)

Kimberly also had a photo opportunity with her father, as they rescued a Box Turtle together on their way to take her back to the Academy (see Figure 24).

Figure 24. *Photograph by Kimberly Shared during Second Photovoice Focus Group.*

> *Kimberly begins to tell the story behind the Box Turtle photograph to the group (Andy, Jasmine, and Mary).*
>
> Kimberly – I had been telling my dad about everything I had learned in class while they were out together over the weekend running errands. Later when my dad was taking me back to the University, he said 'Kimberly, I just saw a turtle on the road.' I was like, 'Turn the truck around now!' and he did. I explained to him that we needed to place the turtle in the direction it was headed. But before we put it back, I wanted a photograph but the grass was too tall so we put it on my dad's truck for a minute to get a photograph. (Photovoice focus group, 7/3/13)

As indicated in these examples, participants also had opportunities to go outdoors with their families, which further strengthened their sense of place. They were also able to help their families make connections to the organisms and opportunities arose on these trips to discuss the natural world.

Summary: Principle d. As students' strengthened their sense of place by developing their place identity and place attachments, students needed to work through their discomfort, much like actual field ecologists (Leon-Beck & Dodick, 2012). As Leon-Beck and Dodick (2012) found, field ecologist graduate students have to learn to work in all types of environmental conditions and the longer they spend in the setting the more comfortable the student becomes in the place. Casey Allen (2013) also documented that one of the benefits of fieldwork for university students was learning to realize that they could handle stressful and uncomfortable situations.

However, unlike the five participants in Leon-Beck & Dodick's ethnography, the Academy HRE participants did not have to work through the challenge of adjusting to fieldwork alone. Peers and instructors, who encouraged them and cheered as they worked to forget their former discomforts, surrounded participants. Similarly, Alagona and Simon (2010) also led university students in a semester-long field course and found that encouraging each other ultimately led to the students developing tight knit support groups, and Carlone et al. (in press) also found that working through discomfort in the field enabled participants to engage in identity boundary work. Sharing experiences with family and friends also opened doors for participants to discuss their environment and to engage their agency by altering their thinking and asking family members to alter their behavior, such as refraining from killing snakes.

The post-survey also supports the participants' movement toward action in regards to environmental issues. In reviewing the post-survey instrument two questions were selected as descriptors of principle d (see Table 11).

Table 11

Post-survey Results for Principle D

	To what degree did participating in this HRE increase your…[a]	**To what degree did participating in this HRE make you feel…**[a]	
Participant	**Interest in nature**	**Interest in taking care of the environment**	**Average**
Alicia	5	5	5
Barbara	4	5	4.5
Betty	5	5	5
Casey	5	5	5
Elaine	4	5	4.5
Gary	4	4	4
Jasmine	4	5	4.5
Jaylyn	3	5	4
Kadence	3	5	4
Kamal	4	4	4
Kimberly	5	5	5
Mary	5	5	5
Patrick	4	4	4
Quincy	3	5	4
Tabitha	5	5	5
Class Average	**4.2**	**4.8**	**4.5**

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (to a great degree).

Like the post-survey results for principles a, b, and c, the class average for the two post-survey questions was above 4.0 and none of the students rated themselves below a 3. In fact, 13 out of 16 participants selected 5 for *interest in taking care of the environment*.

Like principle c, there was no significant relationship for ethnicity or grades, but the female participants did rate themselves significantly higher than the males ($Z = -2.277$; $p < .05$). This is an important finding in that it demonstrates how the principles build upon each other.

The development of principle c should naturally lead to the development of principle d as understanding of place is directly tied to one's sense of place (Kudryavtsev et al., 2012). This contention is supported by the finding that females have significantly higher ratings for principles c and d. Again, I re-examined my qualitative data, using Dedoose to calculate frequency counts for gender, and there were a similar number of instances for females and males.

Thus, participants were able to strengthen their sense of place, which in turn made them more interested in taking care of the environment, as evidenced by the stories that the scholars shared about their experiences with their families in the outdoors. Lim et al. (2013) found similar results in their study on place, as children displayed agency in developing their sense of place when they were able to engage with others either by being in the place with them or by discussing the place with them. Furthermore, sense of place has been shown to motivate people to act individually and collectively to protect and restore their community (Lewicka, 2011), which also supports the evidence for principle d.

Principle E

Use EE as a foundation for change, such that their identity develops, their position in the world advances, and/or they alter the world towards what they envision as more just.

Principles a, b, c, and d work together and culminate in principle e. Thus, as participants deepen their knowledge, the opportunities to demonstrate their expertise increase. Expertise and knowledge lead to a better understanding of place, which strengthens their sense of place. As the participants deepen their understanding of place and strengthen their sense of place, participants' can further deepen their understanding as they begin to consider and discuss environmental issues present in their communities. Thus, each of the four principles work in concert with each other to help participants begin to change either their identity, position in the world, or what they envision as just. This occurred by participants developing a newfound awareness, which was enabled by their ability to use the environment as a lens, to discover and rediscover habitat, and to see "the beauty of the find." They also engaged in changing the world to what they envisioned as more just by educating others, and they began this journey as they shared their experiences with their families and friends. Finally, participants had opportunities to change their feelings toward herps, which influenced their views of themselves.

Ten initial codes emerged during my qualitative data analysis. I then sorted and collapsed them into three salient themes (see Figure 25). I present and discuss each theme in the following sections.

Developing newfound awareness. Though this theme is closely related to the themes of principle c, it is different in that the newfound awareness embraces more than habitat. It involves how participants think and feel about the larger environment and environmental issues. As Kamal explained during his response to the exit interview question regarding how he viewed things differently in his community, Kamal – It’s almost like before you start driver’s ed. **Before you don’t notice** any of the signs on the street. And then afterwards, **you start noticing** all the signs and you notice where the turns are. I would say, it’s like that. Because right now **I see the small things** – like I’ll see lizards crawling across walls and **wonder how I affect them**. And it’s the things **I wouldn’t have picked up on and didn’t think about before**. (Exit interview, emphasis added)

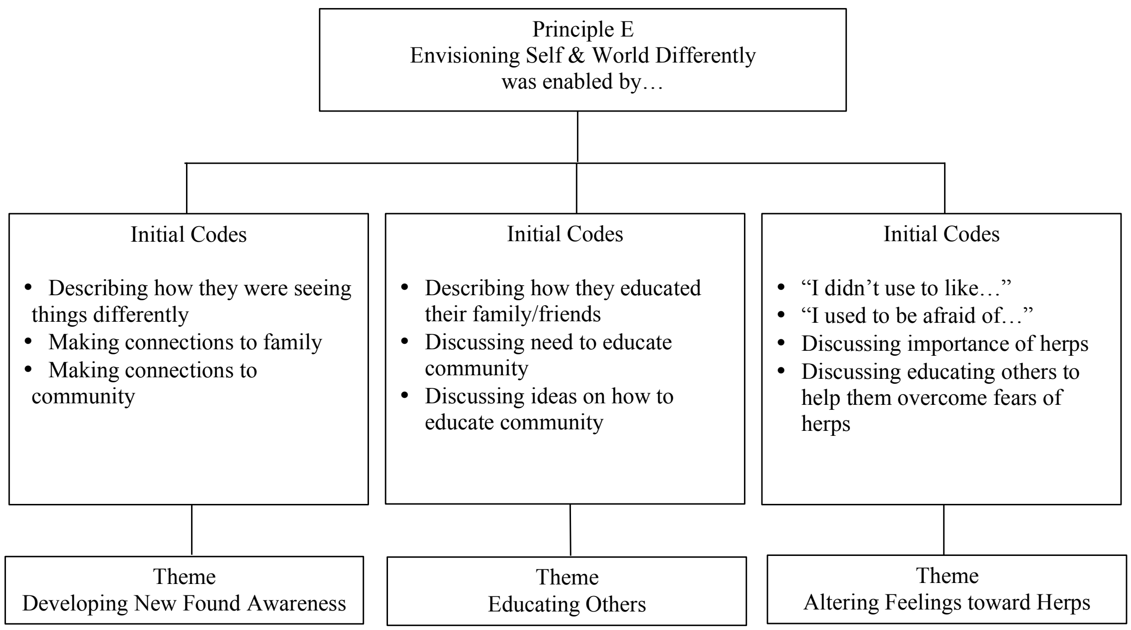

Figure 25. Themes for Principle E.

In answering the same question, Kadence discussed how she had become aware of oil spills from cars, and she wanted to do something about it and planned to discuss her concern with her grandmother, which demonstrates how she was using her agency to alter the world to what she envisioned as more just.

When asked if she noticed anything in her community that she had not noticed before she participated in the Academy HRE,

Kadence – Yes, the cars – I didn’t realize how oil spills from cars affect the environment. My grandfather died, but his car is still in the driveway at my grandma's. But you know it's like his car has oil spills. I did not know that that affected the environment; so, I'm going to talk to my grandma about it when I get home so we can do something. (Exit interview)

Participants also discussed their newfound awareness with each other. On the final day of the HRE while participants were waiting in the hall for everyone to finish their post-test, Barbara began a conversation by simply saying, "So, I want to know what impacted you the most."

The participants have been standing and quietly waiting on others to finish. Once Barbara enters the hall, she instantly sits on the floor with her legs crossed. She pats the floor for others to join her.

Barbara says – So, I want to know what impacted you the most.

Betty is the first to sit down.

Betty – I definitely see the environment in a whole new way than I did before I started. Like with the slug, I would have poured salt on it rather than picking it up and putting it somewhere else.

The other participants (Elaine, Gary, and Patrick) are now sitting down as well.

Barbara – Yeah, when I'm outside at night, I hear the frogs. And like before I thought those were crickets that just made different sounds. But like now, I can like recognize the frogs and I'm like whoa have those always been that loud? What else I'm missing noticing because I don't know about it? It's made me want to learn as much as I can; that's why I came back.

Patrick – Well, they (herps) are a huge part of nature and they are all around us, because everything deserves to live and they were here first.

Gary – Yeah, I noticed all these lizards running across my yard when I went home for the fourth. I never knew they were there. I mean I saw deer but I wasn't looking for the little things.

Jasmine – I liked how we got to see other people's point of views through their photographs. It reminded me of how we all see things through different eyes, but we want to protect those that are smaller.

> *The majority of the participants are finished now and class is almost over, so Dr. T opens the door and tells the participants in the hall to quietly come back in to get their stuff packed up.* (Field notes, 7/11/13)

As seen in this impromptu discussion, the participants developed a newfound awareness, and they were not shy about sharing this with others. Casey also highlights this in his description of the photographs he took for the photovoice project. He describes how his awareness of his land changed and even a weed became an object of beauty to be admired and celebrated.

> *When asked to describe the photovoice project,*
>
> Casey – I got a picture of my pond and I didn't really notice how great it looks. I didn't really realize how much I had around my house until I started taking pictures. So that was really exciting. Plus, I found like this really weird flower in my pasture. I think it was just a weed that I took a picture of, but I got a very good close up shot of it. And it was a great picture that's now my desktop background. (Exit interview)

Mary also expressed how this newfound awareness influenced how she thought of human interactions with animals.

> *When asked to explain why the bioblitz was her favorite field experience,*
>
> Mary – Because you were in nature like with the animals and then you walked three feet and you would be like in his (Casey's) house. It was a nice reminder that there is nature and animals and oh, yeah we're humans and we're a dominant species, but we can coexist. We don't have to exterminate them or get rid of them, we can just leave them be. (Exit interview)

Finally, Patrick's photovoice writing assignment expressed his desire for others to be able to "really see." The caption for the photograph (see Figure 26) was simply "Learning to seeing things differently."

> *In his paragraph about the photograph, Patrick wrote,*
>
> "This photograph portrays how delicate nature can be, and how you have to look deep into nature in order to "really see." Many times people overlook the details in nature, the delicate, the beautiful, and only see what they perceive to be negative like bugs. People are busy/distracted by technology and schedules and don't take time to look around. I want to express the importance of embracing protecting, and observing nature. (Photovoice writing assignment, 6/24/13)

Figure 26. *Photograph by Patrick Used during Photovoice Writing Assignment.*

This newfound awareness that Patrick so eloquently describes aided participants in their pursuit of educating others.

Educating others. Educating others was a theme throughout the Academy HRE. Dr. T often reminded students that they needed to share their knowledge with others, and the photovoice project also emphasized this point. One of the focus group questions that participants had to discuss each week was how each photograph could be used to educate others. Quincy's comment during his exit interview shows how thoroughly students embraced this idea, "**I have a knowledge** of reptiles and amphibians that **I can pass on**" (Exit interview, emphasis added). Barbara also discussed how she began to notice her community needed to be educated, "Because of me not knowing before this class, I've noticed that **my community doesn't know**. They're uneducated about it (herpetology)" (Exit interview, emphasis added). Casey's and Elaine's interviews also highlighted how people do not know a lot about herps and need to be educated.

> *When asked how they would respond to the question, why study reptiles and amphibians,*
>
> Casey – People seem to like species that are more relatable like mammals, because this is what you see on TV and Facebook. **But they don't really hear or see much** about like reptiles, amphibians even though they have so many unique characteristics, so **they need to learn**.
>
> Plus, I've noticed **how little people actually know** about reptiles and amphibians and what's going on. Like when I went to reptile and amphibian day at the museum during the school year. I was helping teach people about herps through our puppet shows. And I was also like teaching kids how to lasso a lizard. I didn't realize how much a lot of people didn't know. (Exit interview, emphasis added)
>
> Elaine – Because some people are confused about like the different types of herps and why they're here. They just kill them for no reason, or they take them out of their habitat when they really shouldn't. (Exit interview, emphasis added)

During their photovoice focus groups, participants discussed how they could use their photographs to educate others. For instance, Tabitha had an idea to use her photograph in Figure 17 to make flyers to inform her neighbors about why it would not be good if the land were developed.

Tabitha shared the following with her group (Gary, Kadence, Quincy, and Patrick) as she explained how she envisioned using the photograph to educate others.

Tabitha– After I took the photograph, I showed it to my parents and explained my thinking to them. They were not even aware of the pools, so that got me thinking that if they didn't know then all my neighbors probably didn't either. So I could make a flyer with my photograph and story on the front. Then, I could take close up photos of pools for the back with some cute pictures of frogs. This made me realize how important conversation is when it comes to educating people because I would have never known my parents didn't know about the small pools. (Photovoice focus group, 6/25/13)

Tabitha's group also pointed out how Quincy could use his photograph (see Figure 27) to educate people on how to properly handle amphibians.

Figure 27. Photograph by Quincy Shared during First Photovoice Focus Group.

In discussing how to use Quincy's photograph to educate others,

Kadence – Look you can tell that his hands are wet, so you could use this to explain to others that it is important to have their hands wet when they handle amphibians.

Quincy – That's right. I wet my hands really well in the creek before I picked up the little guy.

Tabitha – That's an important point too. You used water from the environment, so he is probably used to that source.

Quincy – Cool. I wasn't even thinking of those points. Thanks! (Photovoice focus group, 6/25/13)

Developing ways to educate others enabled the participants to envision their world as a place that could be more just. The participants clearly wanted to help other people understand the importance of herps. The more participants' feelings toward herps changed over the course of the Academy from fear to appreciation, the more they wanted to educate others in order to help them change their feelings toward herps like the participants had. As Casey observed, "It's amazing **how you can teach people** and then **they can get over their fears**. And it turns out to be **they really love it**" (Exit interview, emphasis added).

Altering feelings toward herps. Eight of the participants (Alicia, Betty, Barbara, Elaine, Jaylyn, Kadence, Kamal, and Mary) entered the Academy HRE with negative feelings toward certain types of herps, such as snakes or frogs, and all of them except Kamal purposely took the course to work through their negative feelings. Being able to identify as more of a "herps person" enabled participants to further develop their identities while in the course. Barbara describes in her exit interview how she took the class the year before to specifically work through her fear.

When asked why she took the Academy HRE the first time,

Barbara – Well, I really enjoyed science and I had taken a chemistry class, knew nothing about chemistry, ended up falling in love with it. And so I was like what other science do I love, but don't know yet? So that's one of the reasons. And the second reason (and truthfully the main reason) was because **I was terrified of**

> **everything in nature like frogs**. It all creeped me out. So I took it (the Academy HRE) **to relieve the fear**. And so **it happened**, and now I love it even more than chemistry. (Exit interview, emphasis added)

Alicia, Betty, Elaine, and Kimberly also discussed how they had transformed over the four-week course.

> *When asked to describe herself during the Academy HRE,*
>
> Alicia – Well, in the beginning when the class started **I was hesitant**. I did not want to touch any creatures. But then I really liked lizards, and I held a frog and a toad, although I was kind of scared at the beginning. It was good and then we went out to the field trips, I held some newts. **I was really scared at the beginning but I became excited and adventurous by the end**. (Exit interview, emphasis added)

> *When asked how she would answer someone who asked her why study reptiles and amphibians,*
>
> Betty – Actually my first year in the Academy, I saw the herpetology as an option, and I was like, **I am not signing up for that**. There will be snakes, there will be salamanders and all this other stuff that's really creepy crawly and **I don't' want to touch it**. And this year, I was like, well I guess I could sign up for it and **work through some of those fears**.
>
> Having all those snakes in the classroom was kind of scary at first because the first day she was like reading us the rules and she was like we're going to be holding snakes and so you don't want to give them to people if they're afraid. And stuff like that and I was like how many snakes are in the classroom? **But now I love snakes** and I've held every single snake we have in the classroom, several times in fact. (Exit interview, emphasis added)

> *When asked to describe herself during the Academy HRE,*
>
> Elaine – Well, at first **I wasn't really excited** about it because **I'm not an outdoorsy person**. I like animals, **but I am afraid of certain things**. Like, I don't like to touch them and hold them and stuff. But now that I took it**, I actually liked** it and enjoyed interacting with the animals.

> Interviewer – Okay, if you had three words that you can use to describe yourself or the experience, what would those three words be?
>
> Elaine – I think **I was open, energetic, and excited**. (Exit interview, emphasis added)

In class, Betty readily discussed how her feelings toward herps had changed after she held her first snake. After that experience, Betty was quick to remind anyone who was scared to touch something that it had helped her to get over her fear by holding the snake. In one instance, she told, Jaylyn, who refused to hold a snake until the very last day, "See look at me holding this snake like a pro. Just a couple of days ago I was scared." (Field notes, 6/27/13). Unlike Betty, Alicia and Elaine did not discuss their change of feelings during class.

Another instance of participants altering their feelings toward organisms was when Jaylyn and Kadence, who shared a slight aversion to frogs, had a breakthrough in the classroom when they decided to hold a frog.

> *Kadence has come over to Jaylyn's table, as everyone else is busy getting their frogs out of the containers.*
>
> Kadence – Are you going to hold one? *Jaylyn shakes his head no.*
>
> Kadence – I kind of want to. What if we do it together?
>
> Jaylyn – Okay, I'll do it if you'll do it. We can get Betty to help us.
>
> *Jaylyn leans over and whispers in Betty's ear. Betty nods her head.*
>
> Betty – Ya'll just tell me when you're ready.
>
> *Kadence steps up first and Betty shows her how to hold the frog. Kadence grips it in her hand. Her hand muscles are tense. As the frog just sits there, Kadence begins to relax and she smiles. Jaylyn tells her to hand the frog back to Betty*

> *when she is done and then he will get it from Betty. Kadence keeps the frog for several minutes and has Jaylyn take pictures of her with it. Then, she returns the frog to Betty and the same procedure happens for Jaylyn.* (Field notes, 6/18/14)

The next time the class met, I asked Kadence how she felt about holding a frog for the first time.

> Kadence – I made a frog best friend, because you know I was holding him and he didn't even try to jump away. He was just making his little chest like beat out, but it was my friend. I made a friend. *As she says the last sentence, she widens her smile.* (Field notes, 6/20/14)

After that first experience, Kadence did not hesitate in picking up frogs in the field or holding them in the classroom, as the quote from her exit interview demonstrates.

> *When describing why the ephemeral pool field investigation was her favorite experience,*
>
> Kadence – And the tadpoles I just was not expecting them to look like this. To be – to be honest, I did not really know frogs were tadpoles. Like tadpoles turn into frogs and they go through metamorphosis. I did not know that. So, **this class in general was like something I would never knew.** So just to feel them, it's like so kind of like slimy and wet. **And I never thought I would touch it. And I did.** And then some of them did not have legs on them. And some of them had grown legs already.
>
> And **I actually held a frog in the wild** – and I did not know you have to hold it by its legs until I held the one in class. You don't want to grab its stomach. (Exit interview, emphasis added)

Jaylyn was still slightly hesitant, but even his transformation of feeling was noticed by his siblings, which he shared during a photovoice focus group. Jaylyn explained how his siblings were surprised when he led them to the back of the pet store where the amphibians and reptiles were because he normally would not go back there.

One final example of participants' altering their feelings comes from Andy. Though Andy arrived at the Academy HRE already comfortable with herps, he viewed snapping turtles as mean, aggressive animals. To fully understand how Andy's feelings changed, I need to first describe the instance when the group encountered a small snapping turtle.

> *Six aquatic turtle traps and twelve minnow traps line the circumference of the small pond. Dr. T and I had visited the day before to set the traps in the pond. Participants take turns checking the traps. As we reach our final trap, Andy and Gary go into the water. As they lift the trap, it is apparent something (other than fish) is in the trap. The excitement of the group mounts. Once the trap is on the land, Mr. J Hall (the state's herpetologist) takes over as he realizes the trap holds a snapping turtle. Andy and Gary scramble up the small bank. As Andy turns to Gary, he comments:*
>
> Andy – I cannot believe we were in the pond with that creature. Glad I had on these waders.
>
> *Gary nods and makes a comment under his breath, which is inaudible to me.*
>
> *Mr. J removes the snapping turtle from the trap. Once it is free, he carefully picks up the turtle and holds it for the participants to see. The turtle, not enjoying the attention, continues to open and shut its large, beak-like mouth. Andy makes another comment to Gary.*
>
> Andy – That is one mean animal. I've always heard that (that they were mean) That's one herp I'm not sure we should protect.
>
> *Continuing to hold the snapping turtle, Mr. J points out features of the turtle that make it vulnerable to predators (e.g. the small plastron, which exposes more flesh) and says*,
>
> Mr. J – This is why these turtles are so much more aggressive than other semi-aquatics (referring to other semi-aquatic turtles). They have much more exposed areas of flesh and must fight to protect themselves from predators that would like to take a nibble. (Field notes, 7/2/13)

Several days after the bioblitz field investigation and Mr. J's visit, Andy turned in a photovoice writing assignment (see Figures 28 and 29), which indicated his feelings toward snapping turtles had changed.

Figure 28. First Photograph by Andy Used during Photovoice Writing Assignment.

Figure 29. Second Photograph by Andy Used during Photovoice Writing Assignment.

> I think this photograph should be captioned: I have a RIGHT to protect myself. I didn't realize until Mr. J's visit the reason snapping turtles were so aggressive. After learning more about them, I understand them and I would act the same way if I were them. I think I can use this photograph to educate others because the snapper looks mean in the photograph, but I can explain to them why he looks

> that way and show them the picture of his underside and all the flesh. I can tell them he is only trying to protect himself, which like us, he has the right to do. (Photovoice writing assignment, 7/8/13)

As demonstrated by the above examples, the Academy HRE provided a space through which students could work through their feelings on their own terms. This agency enabled participants to engage their CEA and further develop their identities as people who can participate in field ecology.

Summary: Principle e. Using EE as a foundation for change began as participants developed a newfound awareness, learning to think and engage in discussions in new ways. As their awareness developed, participants began to envision a world, where they were able to educate others about herps leading to a better understanding of the organisms and a desire to address environmental concerns affecting the herps. In addition to this, several participants went from being fearful of the organisms to feeling comfortable, which increased their ability to interact in the classroom and participate in the field investigations.

The post-survey also supported these themes. In reviewing the post-survey instrument, three questions were coded. The results provide evidence that participants feel it was possible for them to educate others and to see themselves having characteristics that scientists have (see Table 12). Unlike the post-survey results for the other principles, the class average for one of the post-survey questions (*talk like a scientist*) was below 4.0. Even though students readily used scientific vocabulary during class, on the field investigations, in their focus groups, and in their exit interviews, it seems participants had conflicting thoughts on whether participating in the Academy HRE made them feel like it was possible for them to *talk like a scientist*.

Table 12

Post-survey Results for Principle E

	To what degree did participating in this HRE make you feel like it is possible for you to…[a]			
Participant	**Think like a scientist**	**Talk like a scientist**	**Teach others about amphibians and reptiles**	**Average**
Alicia	5	5	5	5
Barbara	5	4	5	4.67
Betty	5	5	5	5
Casey	3	3	5	3.67
Elaine	4	3	5	4
Gary	3	2	3	2.67
Jasmine	4	4	5	4.33
Jaylyn	4	4	4	4
Kadence	4	3	5	4
Kamal	4	3	5	4
Kimberly	3	3	5	3.67
Mary	4	4	3	3.67
Patrick	4	3	3	3.67
Quincy	4	2	4	3.33
Tabitha	5	5	5	5
Class Average	**4.07**	**3.53**	**4.47**	**4.05**

Note. Bolded names were second year participants (SRAs).
[a]Likert scale rating of 1 (not at all) to 5 (to a great degree).

Of particular interest are Gary and Quincy, who both rated themselves at a two; yet, both discussed in their exit interview that knowing terminology made them feel "sciency."

When asked to describe a moment where they felt really "sciency,"

> Gary – When I could describe – like one day in class we were talking about turtles. We had the shell and were identifying the parts, and I knew where each of them (the parts of the turtle shell) were on it. (Exit interview)
>
> Quincy – Every time we started a new herp and she (Dr. T) said the genus and species, or any time when we were talking about an animal and we said the genus and the species name. Because I knew about genus and species from biology. It was only a couple of things that I knew, but I knew I had a background so that was really cool.
>
> Interviewer – Okay. And what was it about that moment that made you feel "sciency" or made you feel like you were doing the science?
>
> Quincy – Because the scientific names were big words.
>
> Interviewer – Were there other moments like that where you felt sciency?
>
> Quincy– When we would describe characteristics of it (the herp) and then we actually got to see what characteristics we talked about were (when interacting with live animals). That was pretty cool. (Exit interview)

Though the above quotes indicate Gary and Quincy associated vocabulary use in class with feeling "sciency," the post-survey results indicate that they did not feel their participation in the Academy HRE made it possible for them to *talk like a scientist*. The other two questions (*think like a scientist* and *teach others about amphibians and reptiles*) reflected the general trend of the other principles, with class averages above 4.0 and no participant rating below 3. Following the pattern of principles c and d, neither ethnicity nor grades showed any significant relationships; however, gender did. Again, females rated themselves significantly higher than males did ($Z = -2.289$; $p < .05$), which supports how the principles work together to form CEA. Yet when I ran frequency counts in Dedoose, my results yielded a few more instances for males than females.

The post-survey results indicate that the participants felt it was possible for them to *think like scientists* and to *educate others*. Both of these statements are representative of principle e in that thinking like a scientist is an indicator of participants' developing science identities and educating others was one way the participants envisioned a more just world for herps in their community. This process of envisioning can be compared to visualizing in critical literacy, when a student creates images in her mind that represent ideas she interprets from the text (Chambers & Radbourne, 2015). Thus, as participants strengthen and engage principles a-d, they begin to create images in their minds from their interpretations of the environment, which supports and develops principle e.

CEA

Though the principles were teased apart for data analyses as mentioned earlier, the principles are designed to work closely together, and as I analyzed my data the lines occasionally blurred as I coded the data for each principle. Thus, I found it necessary to create an overall category for data analysis because subsets of codes were not mutually exclusive. This category served as the place to store codes that continually spanned two or more principles, which ended up being fourteen codes. I then sorted and collapsed them into three salient themes (see Figure 30). I present and discuss each theme in the following sections.

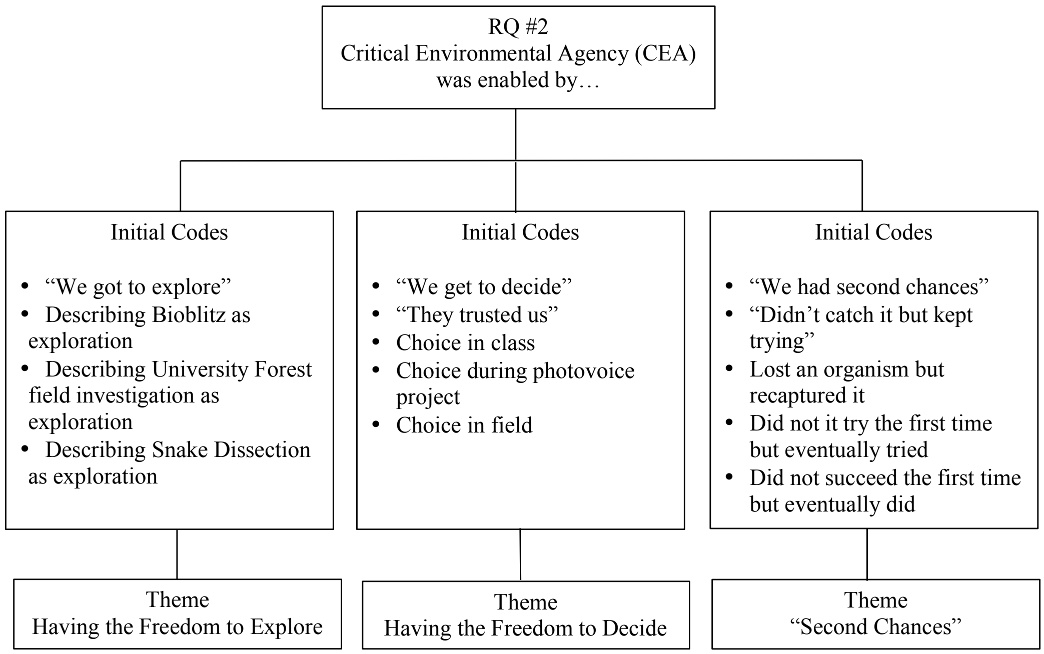

Figure 30. Themes for CEA.

Having the freedom to explore. During the Academy HRE, participants were often given the freedom to explore in the classroom and in the field. Participants continually referred to this freedom, and it became a factor in their developing CEA, as they were able to explore like experts while deepening their understanding of place and strengthening their sense of place. During their exit interviews, Jaylyn, Quincy, and Alicia contrasted the freedom in the HRE to the constraints placed on them in school science.

> Jaylyn – This really interested me when I first heard about it in the interview for the Academy. It made me feel like I was **going to actually be able to do something with animals, without being in trouble**. (Exit interview, emphasis added)

This statement was further explained later in Jaylyn's interview when he told why the ephemeral pool field investigation was his favorite.

> Jaylyn – Because all the animals were there and you could catch things and it wasn't like, **you can't do that, you can't do this**. The only thing you really couldn't do was like pick up the animals with your dry hands, which would have hurt the salamanders. So, **it made it like open and free**. (Exit interview, emphasis added)

Quincy's response was similar to Jaylyn's, as Quincy explained why the ephemeral pool and bioblitz were his favorite experiences.

> Quincy – Because we got to **actually get out there and catch things**. And look at them – **look at them like in the wild** and see what they eat and where they hide. And we go to see their habitat, **not just like talk about it and look at it like in school**. (Exit interview, emphasis added)

Alicia contrasted dissections in school with the snake dissection in the HRE when explaining how she was adventurous in the Academy HRE but not in school science.

> Alicia – And they (teachers) **didn't really let us** cut out organs so we could feel it or anything. They (teachers) **told us exactly** what to do and if we did something else we would get in trouble. Here, we were **able to explore** and we all found the organs from the diagram on the board. She (Dr. T) **let us go our own way** I cut out some of the organs and I found the heart. I took the eyeball out. (Exit interview, emphasis added)

Tabitha also highlighted the freedom to explore in the dissection, as she described her "wow" moment during her exit interview.

> Tabitha – First we had to identify all the body parts on the board and after that we could pretty much **explore our animal** and dissect it and see what's in its stomach. And so after we got done doing all of that, we had free time **to explore**

even more. And I decided to skin the snake. So yeah, I skinned the snake and then it was about time to go, so we got done and I left the snakeskin drying out.

Andy, Kimberly, and Mary also discussed the freedom to explore they experienced during the field investigations.

When asked why the bioblitz was their favorite experience,

Andy – Because we got to see different habitats, many different habitats. We had a pond, we had woods and a horse pasture. We got to check under logs, so there was a bunch of different places we checked. We **were exploring to find any herps**. We surveyed the land. (Exit interview, emphasis added)

Mary – We actually got to look in their (herps) habitats. Like we rolled logs and I learned that I'm not just supposed to kick it over, I have to get behind it and like pull with my hands so it (whatever might be under the log) doesn't like run out and attack me. We **got to explore** and check all kinds of habitat. (Exit interview, emphasis added)

When asked to describe how she felt about the bioblitz,

Kimberly – It was neat because **we just found whatever we could find**. (Exit interview, emphasis added)

An exchange between Andy and Dr. T also exemplifies how the freedom to explore enabled participants' CEA.

Dr. T gathers the large group together, and she breaks them into two smaller groups.

Dr. T – The only rules are don't go over the fences. Other than that you need to cover as much of the area as possible. I'll be going back and forth between the groups, but if you find something, just yell and I'll head your way.

Andy – So **we can explore** anywhere in here?"

> Dr. T – Yep, just no climbing fences.
>
> *Andy turns to Gary.*
>
> Andy – Dude, this is going to be awesome. Let's go. We'll go deep in and leave the closer logs for the others.
>
> *Andy and Gary start off toward the woods and walk in several meters before they start turning logs.* (Field notes, 6/28/13)

This vignette shows how exploration allowed Andy and Gary to go deeper into the woods to search for habitat. It also shows how exploration led to participants having the freedom to decide where they were going to explore, which is the second theme that emerged.

Having the freedom to decide. CEA was also enabled when participants were given the freedom to make decisions about their learning and exploration. For instance, Dr. T is known for allowing the participant to decide whether she wants to touch or hold an organism, and Alicia confirmed this during her interview, when she explained what helped her to take the class, "She (Dr. T) told me that I didn't have to hold them if I didn't want to. **It was my choice**" (Exit interview, emphasis added).

Kimberly and Quincy also discussed how the photovoice project gave participants the freedom to decide because they had to choose what was most important.

> *When asked to describe the photovoice project,*
>
> Kimberly – Yeah, well for a lot of it **we did it on our own and made our own decisions.** If you found herps, you could take pictures or **you could decide** to take a photo of different environments where herps could be found or habitats that could be a concern. (Exit interview, emphasis added)
>
> Quincy – Well, when she told us our homework was to take pictures but didn't really tell us what to take pictures of. **We had to decide**, and when we got here

> (Academy HRE), **we picked our favorite picture** and they printed them out for us. It was good because **we noticed things** other people might not notice because it was our neighborhoods. (Exit interview, emphasis added)

As Quincy's quote shows, the freedom to decide what photographs to capture enabled the participants to be the experts of their community, which was also discussed earlier in research question one.

Finally, Mary and Tabitha detailed how they were able to decide where and when they explored on field investigations.

> *When explaining why the bioblitz was their favorite experience,*
>
> Mary – Being able to look – the looking for them (herps) was fun because like, oh yeah, there's a log, let's move that over and like we'd all be on the same side, just like pulling it over. Like the one person ready to catch stuff if something ran out. **We decided** where to look and **we determined** what was important habitat. (Exit interview, emphasis added)
>
> Tabitha – We got **to do things ourselves** and I felt like **we didn't have to wait** – like in school, we have to wait for our teachers to do it first. Like we could get in there, **decide where to go**, **and do it ourselves** and we could put on the waders and do it and go and check the turtle traps. (Exit interview, emphasis added)

As Tabitha's statement indicates, the participants were able to do things themselves, which enabled their CEA by allowing them to contribute to their learning and by recognizing them as experts who can make decisions about where and when to look for herps.

"Second chances." The final theme that spanned the principles of CEA was that of having "second chances." This actually came from Patrick's quote at the end of his interview when he was asked if he had anything else to share about the Academy HRE, “Just that we get **second chances** like when we’re holding frogs and they’ll jump out of our hands. We can try to catch them again.” (Exit interview, emphasis added). As Patrick’s statement attests, participants had multiple opportunities throughout the HRE to engage with animals, explore their communities, and connect with nature. Tabitha also highlighted how there were “second chances” to interact with animals in the classroom when she explained what she enjoyed about the HRE.

> Tabitha – Because they don’t’ force you to hold them, you know you do it on your own time. And if you don’t feel comfortable one day, you come in the next and maybe you’ll feel comfortable. And then that’s when you’ll give it a shot. So I really liked how **it wasn’t like you had to hold it that day or you’ll never get the chance again**. (Exit interview, emphasis added)

Quincy shared a story during his interview where he worked with Mr. J, the state herpetologist, to recapture a Green Frog that escaped.

> Quincy – And with the bullfrog, it was under like a flap in the pool. So we had to lift it up and Mr. J caught that with a net. Then we had to do the same thing for a green frog and I didn’t know green frogs are fast. So he was like – he let me try and catch it, but it got away because I didn’t know it was that fast. And so it came back up and stuck it’s head out of the water, and **I thought I get another chance, which is what I love about this class.** So we got it corned in one little section and I put the net over it and I grabbed it and it was still hopping everywhere. (Exit interview, emphasis added)

Gary also emphasized his love for “second chances,” when he described how he captured his first photovoice photograph (see Figure 31).

Figure 31. Photograph by Gary Shared during the First Photovoice Focus Group.

> *Gary shares with his group (Kadence, Quincy, Patrick, and Tabitha) how he captured his photograph.*
>
> Gary – We were at a local place doing a service learning project, and we started seeing frogs hopping everywhere. We ran to get our cameras, and we kept trying and trying to catch a frog but they were so small. But we didn't give up, and we finally got one but it got away. However, I was able to catch another one even though the first one escaped, **that's what I love about herping, the chance to try again even if you fail the first time**. Then, I decided I wanted a photo of the frog on the ground so you can see how small it is. (Photovoice focus group, 6/25/13)

Gary also experienced a second chance in the classroom when the class held snakes for the first time.

> *Dr. T has the students prepared as she removes the first snake from its cage. She hands the snake to Kamal, who has a pet snake. The next one goes to Casey, and the final one to Barbara. Kimberly and Andy are chomping at the bit to hold one. Kamal brings his snake over to their table.*
>
> Kamal – Okay, are you ready? I have one at home, so I can share.
>
> *Andy holds out his hands and Kamal makes the transfer. Andy holds the snake. Gary is sitting beside him and neither he nor Andy notices that the snake is getting close to Gary. The snake begins to slither up Gary's arm.*

Gary – Get it off. Please, get it off.

Andy lifts off the snake and quickly hands it to Kimberly across the table.

Andy – Hey man, I'm sorry. I should have been paying attention.

Gary – No big deal. Thanks for getting it off.

Andy – Before you know it, it will be like second nature for you to hold one of those. You'll have plenty of chances.

Gary watches Kimberly hold the snake.

Gary – You know I think I should hold it since it's already been up my arm.

Andy – That's it, man. Way to go. Okay, Kimberly, do like Dr. T showed us and keep the head away from him until he is comfortable.

Kimberly begins to transfer the snake to Gary. She stands beside him for a minute, simply holding the head, while Gary gets a feel for the snake.

Kimberly – You ready to go solo?

Gary – Ready.

Kimberly steps up away but she and Andy are both within range to grab the snake if Gary needs them to do so. Gary lets out a breath and smiles. Jasmine comes up with a camera.

Jasmine – Okay, Gary, now smile. We got to get this.

After the photo is taken, Gary hands the snake back to Andy, but this time when the snake comes near his arm, he reaches out and touches its skin. (Field notes, 6/27/13)

Though Gary took advantage of his second chance on the same day, some participants, like Alicia, Jaylyn, and Elaine, did not attempt to hold a snake until the final day of class.

Summary: CEA. The three themes presented in this section afforded participants multiple chances for success, which enabled them to deepen their understanding of herpetology and the practices of field ecology. The themes also demonstrated how the participants were treated as experts, in that they were expected to know when they were ready to try something like holding a snake or where good habitat would be for herps during field investigations. Participants deepened their understanding of their communities as they decided what photographs to take, which strengthened their sense of place and afforded them opportunities to discuss environmental concerns of herps. Finally, students began the process of envisioning a more just world as they had the freedom to decide and discuss how to share their knowledge and photographs to educate others.

Since the post-survey was analyzed for each this principle, I was able to calculate a CEA score for each participant (see Table 13). This was accomplished by averaging the sixteen questions I had previously coded as descriptors for the five principles.

The post-survey results are indicative of CEA development, as all participant averages are above a 3.5. Alicia had the highest overall average of 4.94, while Gary had the lowest average of 3.56. Analyses of ethnicity, gender, and grades rendered no significant relationships.

Giving participants the freedom to make decisions during the Academy HRE (e.g. what to photograph and where to look for herps during field investigations) provided opportunities for students to have experiences similar to beginning field ecologists, as Bowen and Roth (2007) found in their ethnography of field ecology graduate students.

Because university supervisors were often absent during field research, graduate students had to make decisions regarding procedures and methodology on their own. Similar to the findings regarding participants' freedom to explore, Lim et al. (2013) also showed children were able to display agency in the development of their sense of place through active exploration of their neighborhood. Having multiple opportunities was also of paramount importance as participants could keep trying until they were successful, which aided their agency. Thus, freedom to explore and make decisions seems to have a positive impact on students' comfort in the outdoors.

Table 13

Post-survey Results for CEA

Participant	**CEA Score**
Alicia	4.94
Barbara	4.44
Betty	4.88
Casey	4.31
Elaine	4.19
Gary	3.56
Jasmine	4.25
Jaylyn	4.31
Kadence	4.19
Kamal	4.19
Kimberly	4.19
Mary	4.25
Patrick	3.94
Quincy	3.81
Tabitha	4.88
Class Average	4.29

Note. Bolded names were second year participants (SRAs).

Summary: Research Question #2

In his place-based framework, Sobel (1996) describes a curriculum, which starts by fostering empathy, moves to exploring the local community, and culminates in social action. In essence, this was the framework used in the Academy HRE. Unlike formal schooling, the Academy was not a "high stakes" environment for the students, though students desired to be successful and to be seen as successful. There were opportunities for students to take risks in the classroom and during the field investigations. Yet, the atmosphere was extremely supportive, and students readily shared their knowledge with those outside the Academy. Deepening their understanding of herpetology and the practices of field ecologists (principle a) enabled participants to develop and use their herpetology expertise (principle b). Findings from research question one provided evidence for the success of the community-based investigations, which afforded participants experiences, which deepened their understanding of place (principle c) and led to them discussing ways to protect the environment (principle d). Finally, engaging with friends and family on the weekends, working toward community exhibits for the photovoice project, and discussing ideas with Academy peers afforded participants specific opportunities to begin to change their world to what they envisioned as more just (principle e).

Research Question #3

How was CEA constrained during the field ecology program?

As discussed previously in Chapter 3, the Academy HRE was selected as the study site due to its alignment with the principles of CEA and as discussed in research question two, CEA was enabled throughout the Academy HRE. Yet, as Spradley (1980) recommends for researchers conducting an ethnographic study, I also analyzed my data to find points of contrasts and contradictions in order to determine how CEA development was constrained in the Academy HRE.

Multiple qualitative data sources were used to answer this research question. After I had analyzed my data for research question two, I went back through my qualitative sources and searched for any instances when any of the five principles of CEA were constrained.

Once I had collected the contrary examples, I explored the sources for themes and three emerged: (1) Understanding of urban environments; (2) Understanding of environmental issues; and (3) Positioning one's self. In the following sections, I will present my findings for each theme.

At this point, it is important to remember that the Academy HRE was selected because it served as an exemplar space to study CEA. The participants all came from underrepresented backgrounds in higher education in regards to class (low socioeconomic) and educational history (no 4-year college attendance for family members). The mission of the Academy is to help the students learn to persist through adversity and engage their agency in order to be successful in their goals of attending and graduating from college. The Academy also places a large emphasis on social action, and students engage in various service-learning projects centered on educating younger students about college readiness (e.g. putting on a college fair for a local middle school) throughout their time in the Academy. The students often view the Academy as a safe and supportive place, where they learn to be comfortable with who they are while at the same time learn to take risks and try new things as this is essential for their success in college since they will be the first in their family to attend. Tabitha's exit interview highlights this: "But it's good because everyone here – this is like a really strong environment. And everybody here is comfortable around each other. We're here to encourage each other" (exit interview). I believe the structure and culture of the Academy HRE greatly contributed to the fact that there seemed to be few constraints.

Understanding of Urban Environments

Prior EE research has found that most EE, whether urban or rural, uses pristine environments as models to teach students EE principles (Barnett et al., 2011; Fisman, 2010; Sullivan, 2008). In fact, Haluza-Delay (2001) observed that after an intense 12 day nature experience, eight suburban youth characterized nature as fundamentally different and distinct from their home communities. Nature was discussed as a place that is left undisturbed by humans, a natural area not constructed by humans, and an environment that is far away from urban areas. Humans were also categorized as not being part of nature. The youth implied that their home environments were already polluted, degraded and unnatural. Thus, there was no need to be concerned about the environmental conditions of their communities (Haluza-Delay, 2001).

Fully aware of this research, Dr. T altered the Academy HRE field investigations each year to include field investigations in urban areas in the students' communities, as discussed in research question one. However, students understanding of urban areas still, at times, constrained their CEA development. For instance, in describing himself in the

Academy HRE, Jaylyn stated, "I was very happy (except for snakes) because we were going on field trips and catching things. It was fun because **I used to live in the country**, like the deep country, and **we used to go and catch stuff** on our land." (Exit interview, emphasis added).

This statement shows how Jaylyn associated field trips and catching herps with the country. Jaylyn, now residing in a more urban area, describes how he and his family used to have nature experiences, even though he mentioned going to the local park with dad to take photographs for the photovoice project. He appears not to equate the two experiences as being similar. Jaylyn's limited understanding of more urban environments also appeared in a conversation with Betty.

> *Jaylyn and Betty are packing up as class is over. Betty asks Jaylyn what he's doing this weekend.*
>
> Jaylyn – Oh, I'm excited because I'm going to my grandparents so I can take photos for our homework. They live in the country like you, so I should get good photos. (Field notes, 6/2

Again, this conversation highlights how Jaylyn was constrained in his understanding of more urban environments and habitats, as he associated taking good photographs with the country.

Gary and Kamal had similar views of urban areas. During his exit interview, Gary explained that he had started looking for herps in his community: "Especially at my grandparents because **they live way out in the country**." This statement came almost immediately after Gary had shared his amazement of seeing so many skinks in his own yard. Kamal also struggled to connect seeing skinks as evidence for herp habitat, as evidenced by the vignette below.

> *The participants returned from their first weekend home last night. They have entered class excited and several students (Kimberly, Kadence, Betty, Quincy, and Patrick) have their cameras out and are sharing photos. Dr. T tells everyone to get out their cameras so we can download the photos and they can pick their favorite photograph. I start with table 1* (see Table 4 for groupings) *for the downloading. When Kamal brings me his camera, I ask him how it went.*
>
> Kamal – Well, you see I live in an apartment complex and I don't have any good herp habitat. I only have four photographs (the assignment was to take at least six). I feel bad that I couldn't do the whole assignment.
>
> *I assured Kamal that his photograph of the hawk was an excellent example, and we discussed how he did take the photograph in his community. I told him I was proud of him for thinking so fast as to snap a photograph. As Terry called the class to order, Kamal whispered, thanks. I made a note to share this conversation with Dr. T when we meet to reflect about the class.* (Field notes, 6/24/13)

Interestingly, the next day when I was teaching about lizards and asked if anyone had seen any lizards at their house, Kamal said, "We have tons of skinks. I see them all the time at my apartment complex. There are some outdoor cats that like to chase them." (Field notes, 6/25/13) Kamal also discussed this during his exit interview when he described a moment he felt like he was learning.

> Kamal – Definitely when we were learning about the Green Anole, because when I think of a lizard, I most of the time think of skinks – because I see Five-lined skinks a lot at my apartment. But a Green Anole was definitely something that I enjoyed learning about. (Exit interview)

These examples demonstrate how Kamal's CEA was constrained in that he did not connect seeing skinks at his apartment complex to evidence of there being habitats for herps.

In explaining how she began to see her community differently, Jasmine also revealed how she equated finding animals to living in the country, "Like my friends **live out in the country** and I didn't really think about how many animals there really could be out there before this class" (Exit interview, emphasis added). In fact, Jasmine shared in her first photovoice focus group that she went to a friend's house to take photos because "I couldn't find any places like we had been" (Photovoice focus group, 6/25/13). This statement was made after the Box Turtle field investigation, which occurred in an urban city park. Yet, Jasmine still seemed to be looking for more pristine areas to photograph.

As discussed previously in research question one, participants also struggled with viewing a local city park as potential habitat for herps during the Box Turtle field investigation. This field investigation was the only one that participants did not discuss during their exit interviews. All 16 participants had visited the park before and had various experiences (e.g. playing softball, visiting with family, riding on the carousel) in the park. A couple of participants (Elaine and Gary) even commented on how they had seen frogs and tadpoles in the stream running through the park. Throughout the trip, Dr. T and the park employee pointed out potential Box Turtle, frog, and lizard habitat, but this did not seem to affect participants' views that they would find any herps. As Kadence commented, they were "in the heart of the city" (Field notes, 6/18/13), and the youth appeared to distinguish this from the other field investigations. They were unable to connect herps having habitat in urban areas.

As these examples show, participants' lack of understanding of how urban areas can provide habitat for herps at times constrained their CEA development, as participants struggled to view natural areas in urban environments as potential herp habitat. It should be noted that after telling Dr. T about my conversation with Kamal, we decided to open the assignment and give students the option of using photographs from their field investigations or from their neighborhoods for their photovoice projects. We believed this would allow all participants to feel as if they could participate in the project since participants' time at home was limited during the 4-week course. This decision could have affected participants' perceptions of urban areas, as they were not necessarily forced to grapple with trying to find herp habitat in their neighborhoods.

Hashimoto-Martell, McNeill, and Hoffman (2012) had similar findings in their study of the impact of an urban ecology course on middle school students. In analyzing content knowledge, environmental attitudes, and responsible behavior, the authors found that students did have a significant gain in content knowledge, but there was no significant difference for the pre/post-survey environmental attitudes and behaviors score. However, student interviews revealed that the students did have increased awareness of their environment but were unable to connect what they learned in the classroom to their lives, with only one student reporting a change in his behavior due to taking the course (e.g. he learned about aquatic snails and decided to stop doing destructive things to their environments). As Dunn, Gavin, Sanchez, and Solomon, (2006) put forth, "a great deal of future conservation will rely in part on our interactions with urban ecosystems and the organisms, including non-natives such as feral pigeons (e.g., *Columba livia*), that call them home" (p. 1814). Bearing these findings in mind, additional EE research is needed to better understand how to address these moments of disconnect youth experience when urban environments are used as EE study sites.

Understanding of Environmental Issues

Similar to the first theme, participants' limited understanding of environmental issues sometimes kept them from more fully developing their critical consciousness of place as well as constrained their developing sense of place. Though participants often mentioned human disturbance, they did not delve very deep into an explanation. For instance, in describing the photovoice project, Barbara stated, "Because it gives us awareness of our environment and what we're doing to our environment" (Exit interview). However, she did not elaborate or give an example.

Elaine also gave a general response when she discussed what she noticed about her community, "That we do a lot of things that we shouldn't do to the environment. Well, it comes out of not knowing what stuff is. Like some people put Box Turtles in the water, and they are not good at swimming. Everybody thinks turtles swim" (Exit interview). Though she attempted to give an example, it was not an environmental issue Box Turtles face or herps face; however, she could have been trying to discuss how people mistakenly move animals from their habitat to help them.

Similarly, the discussion that surrounded Betty's photograph of clover (see Figure 32) further exemplifies this.

Betty holds up her photograph (see Figure 32) *for the group (Alicia, Elaine, Jaylyn, and Kadence) to see. She is the last one to share her photograph.*

Facilitator– Okay, what do you see?

Kadence – Well, I see a lot of green and few specks of white.

Alicia – Grass.

Jaylyn – I'm actually wondering if there is any grass there. It looks like weeds.

Elaine – This reminds me of the photograph I shared last week of my yard. Is this your yard?

Betty – Yep.

Facilitator– Anything else?

Jaylyn – I have a question. Is this like one of those "Where's Waldo" pictures and we are suppose to find the frog? *Jaylyn uses air quotes as he is talking.*

Kadence – Oh, I love those books. We should so make a "Where's the Herp" book. *Kadence also uses air quotes for her book name.*

Betty – Can I explain the photograph now?

Facilitator – Of course. That is our next question on the protocol.

Betty – Well, to answer Jaylyn's question, this is not a "Where's Waldo" or maybe that should be Kermit photograph (referring to Kermit the Frog from the Muppets). And yes, it is from my yard and it is simply a photo of weeds. I took it because the weeds to me are a weakness in my community. I mean who wants to go in their yard and see weeds.

Elaine – But what about the bees? They use the clovers for food.

Kadence – Yeah, they need something to eat. (Previously Elaine and Kadence had both shared photographs of bees in separate focus groups.)

Betty – Well, we can still kill the weeds and provide the bees with prettier flowers, which will make them not seem like such nuisance to humans.

Dr. T enters the room and informs the group that it is time to go back to class. The group does not have an opportunity to further discuss the photograph. As the group is gathering their materials to exit the room, Jaylyn comments to Betty.

Jaylyn – You know I liked your idea, but it sure would be expense. Not sure everyone could afford to do it. It costs lots of money to keep your yard free of weeds.

Betty – Yeah, that was my thought too when I was thinking about it, but I still think it'd help people want to go outside more. (Photovoice focus group, 7/3/13)

Figure 32. *Photograph by Betty Shared during Second Photovoice Focus Group.*

In the above vignette, Betty views clover as an issue in her backyard, as most people in the US do (Robbins & Sharp, 2009). She further attests that it displays a weakness in her community and thinks the weeds should be eliminated. Her conversation with Jaylyn seems to suggest she as thinking of chemical weed control. However, the use of fertilizers and pesticides on residential lawns is becoming a major environmental concern (Robbins & Sharp, 2009); yet, Betty appears unaware of this environmental issue and the debate surrounding lawn maintenance.

Given that the course was only a month-long and met for 90 minutes, 4 days a week, it is not surprising that participants were constrained in their understanding of environmental issues, as these are often complex and requires one to understand multiple viewpoints. Though environmental issues such as habitat destruction and habitat fragmentation were discussed during the class, the curriculum did not cover other environmental threats in great detail given the brevity of the course and participants limited understanding of herps when they entered the course. However, when participants did provide more thorough explanations, they almost always centered on those two concerns (see Tabitha's photovoice example in Figure 17). Though this lack of understanding sometimes constrained their CEA, the highest rated question on the post-survey was interest in taking care of the environment, with a class average of 4.8 and 13 participants selecting the highest rating of five.

Positioning One's Self

The final theme, which constrained participants' CEA development, focused on how participants described themselves. These descriptions often centered around not being a science person, not being a herps person, and/or not being an outdoors person. These descriptions in particular constrained principles b and e, as the descriptions affected participants' identity development and positioned themselves as not being a certain type of person.

For instance, Jaylyn referred to himself twice as not "an outdoors person," once on the University Forest field trip (Field notes, 6/28/13) and again in class when talking to Betty (Field notes, 7/3/13). This was interesting as he shared in his exit interview how he and his family used to live in the country and go out into nature. Also, both his comments to Betty came after he shared the photovoice photograph he took while visiting a local park with his dad (see Figure 23).

Elaine also struggled with how she saw herself, which constrained her CEA development.

> *When asked to describe herself during the Academy HRE,*
>
> Elaine – Well, at first I wasn't really excited about it because **I'm not an outdoorsy person**. (Exit interview, emphasis added)
>
> *When asked if she liked science,*
>
> Elaine – Not really because **I'm not really a science person** so I really **don't like science**, it's just that I don't get it sometimes so **I'm not in it too much**. (Exit interview, emphasis added)

Some participants appeared to not associate the Academy HRE with science. For example, Betty and Kadence struggled when asked to define a moment where they felt like they were doing science during the Academy HRE,

> Betty – I don't know because herpetology it doesn't – I know it is science like by definition. But **it doesn't really feel like science. I don't like science that much.** It just feels like you are having fun. Like I would do this for a job and wake up every day and not feel like I'm going to work, but feel like I'm going to a place where I could interact with different animals and have fun with it instead of going to work and sitting at a desk and doing nothing all day long. (Exit interview, emphasis added)
>
> Kadence – Doing science? – I felt like I was having fun the entire time. Like fun like learning and having fun, because my thing is **I'm not a science person**. I just consider it more as life long learning while having fun and interacting. (Exit interview, emphasis added)

Betty's and Kadence's struggle with calling the Academy HRE science gives glimpses into how they viewed science; thus, this constrained their CEA development as they didn't recognize the Academy as science or themselves as people who like science. Casey and Kimberly had a similar discussion during class one day when they were working together to identify frogs.

> *Dr. T has made it around to each set of participants and had her tell them what type of frog they have. She turns to address the class.*
>
> Dr. T – Okay, I want you get up and find a new partner. That's right you can't stay where you are currently seated. Everyone needs to get up and stretch those limbs.
>
> *She gives the participants a couple of minutes to stretch and move around to find new seats.*
>
> Dr. T – Now, let's do it again (identify the frog in the container).
>
> *Casey and Kimberly begin working to identify their frog. This is the first time these two have worked together in class. As they discuss what kind of frog they think it is and come to an agreement once they have consulted their field guide. They begin to talk.*
>
> Casey – You know what I love about this class?
>
> Kimberly – What?
>
> Casey – I can do it. I don't usually do that great in science.
>
> Kimberly – I know what you mean. I never really like see myself as the scientist type, but this I can do.
>
> *The conversation then turns to them discussing what they are planning to do the upcoming weekend.* (Field notes, 7/1/13)

Though Casey and Kimberly experienced success in the Academy HRE, they distinguish this from having success in science; thus, like Betty and Kadence, they position the Academy HRE as separate from what they have experienced to be science in the past.

This finding is similar to Carlone's ethnographic study (2004) of girls in an Active Physics class. She found that even though some of the girls in the class embraced the identity of Active Physics student, this type of science identity did not translate into the girls further developing their general science identities. The girls who positioned themselves as "lab people" still did not label themselves as "science people" at the end of the term. Much like some of the Academy HRE participants, positioning themselves as "herps people" but not necessarily "science people."

In addition to theirs views of science, some students' views of their "future self" conflicted with them identifying with herpetology, as in the case of Alicia and Andy.

> *When responding to was she the same in school science as she was in the Academy HRE,*
>
> Alicia – I **do know that I love science**, but **I don't know if I would go into like the reptiles and animal science**, but I am interested in health sciences and want to be a nurse. Even though I love lizards and turtles. (Exit interview, emphasis added)

Alicia's statement reveals that she did not appear to connect herpetology with her interest in the health sciences even though using herps as environmental indicators for public health had been discussed several times during the class.

> *When asked to explain why the bioblitz was his favorite experience,*
>
> Andy – Well, I mean I might not take this class again. It just depends on what happens next year, so **I might never get to do this again**. In, my future occupation, **I am going to be a chemist** and **it's really not involving herps**. (Exit interview, emphasis added)

Andy's statement is interesting given Andy shared several times during the class how he goes exploring in the woods. Yet, it does not appear that he thought his personal explorations could be viewed as similar to the bioblitz.

Kamal seemed to not identify with herpetology for two reasons: (1) his intense fear of frogs and (2) his views of science ability.

> *When asked to describe himself during the Academy HRE,*
>
> Kamal – I would say usually I'm an outgoing person, but **I'm not really a herpetology person**. At first, I was scared because **I don't like amphibians at all**. (Exit interview, emphasis added)

> *When describing himself during school science,*
>
> Kamal – Oh, **I don't like school science** because I struggle with science a lot. I still love the idea and concepts in science. It's just – **it's not what I'm good at it**. (Exit interview, emphasis added)

As seen in these quotes, Kamal positioned himself as not being good at science, which could constrain his CEA as this view of himself would counter his development as an expert in herpetology, meaning someone who can do and understand herpetology. In fact, this tension is witnessed later in his interview when he finished explaining how he captured a frog to keep it from escaping even though he had not really wanted to, and the interviewer made a statement about him being a herpetologist.

> Interviewer – Cool. You were the herpetologist.
>
> Kamal – No, **I can't see myself being like a herpetologist**. When I get older and if I have kids, I will definitely take them out into the yard and nature and let them look for different things like herps just so they can experience it to see if they like it and to develop connections with their environment. (Exit interview, emphasis added)

Though Kamal does not accept the interviewer calling him a herpetologist, he is open to teaching his future children about herps and cultivating their connections to the environment, which is evidence that though Kamal's CEA was constrained by his views, there were still moments that enabled him to further develop his CEA, as he envisioned a future self spending time in nature with his family.

Only one of the participants, Tabitha, discussed the role of gender in who typically does field sciences, like herpetology.

> *When asked to describe why she was proud of herself for being the first to correctly use the lizard lasso,*
>
> Tabitha – Maybe because the international student didn't get it the first time and I did. And I don't know I just felt good because **you don't really see girls into like herps and stuff like that**. And I was just like yeah, I got it guys. So it was pretty good. (Exit interview, emphasis added).

This comment is interesting since the instructor, Dr. T, is female. Also, I served as an instructor throughout the course and am female. Yet, this does not seem to be a point of contention for Tabitha but rather a point of pride, that she was a girl and she was the first one to do it when girls are not usually into herps. This comment is also intriguing in that it is the only time that I found a gender reference in the data. There were no discussions of girls not doing herpetology or science observed in the classroom or during the field investigations, though I acknowledge conversations could have occurred that I did not directly observe or they could have occurred during other times in the Academy.

How students view themselves and their abilities can greatly affect their ability to further develop their CEA. Students are constantly engaging in identity work. As Carlone et al. (in press) found, the Academy HRE provides opportunities for identity work while students are there, but conclusions cannot be drawn on how students' long term identities are affected without longitudinal data.

Summary: Research Question #3

Though the Academy HRE was purposively selected for its alignment with the principles of CEA, there were still times when CEA was constrained for the participants. These instances most often occurred when participants' understanding of urban areas conflicted with their views of where herps should be found. They struggled to see urban areas as offering habitat for herps even though they admitted to finding herps in urban areas. Yet a couple of students, such as Patrick, who discussed the new urban shopping area and how he wondered if there could be herps in the pond behind the shopping mall, overcame this constraint (Exit interview; Field notes). Another contradiction occurred with participants sometimes seeing themselves as herps people and sometimes not. This can be understood by viewing identity as a fluid concept where participants move back and forth in their views of themselves as they engage in identity boundary work (Carlone et al, in press). Still, it presents possible roadblocks for the further development of participants' CEA. Finally, participants' limited understanding of environmental issues could hamper their CEA development as they are not fully able to engage in discussions, think of ways to alter their behavior, or take action on the issues (principle d).

It should be noted that ethnicity, gender, social class, and classroom culture have been shown to greatly affect students' views of themselves as "science people" (Brickhouse et al., 2000; Brickhouse & Potter, 2001; Carlone et al., 2011; Carlone, Scott, & Lowder, 2014; Carlone, Johnson, & Scott, 2015; Carlone, Webb, Archer, & Taylor, 2015; Johnson, Brown, Carlone, & Cuevas, 2011; Tan et al., 2012). However, there were no perceived constraints in regards to students' ethnicity, gender, or social class, which does not mean that they did not occur but rather were not apparent in the data I collected. In this regard, the participants in my study were selected to be part of the Academy HRE because they came from similar backgrounds, and the students were fully aware that their ethnicity and/or social class were underrepresented on college campuses. This could have motivated them to treat each other with more respect and acceptance.

The instructor for the course, Dr. T, was also the Academy Director and an educational scholar, and it was her fourth summer teaching this course. Therefore, she purposefully tried to cultivate an equitable classroom culture and was constantly reflecting on what this meant and how it could be better achieved. We had several conversations throughout the month-long course regarding how the course could be made more equitable, and Dr. T even altered the photovoice project to be more inclusive after we realized that students were struggling with taking photographs in their community. Furthermore, as I discussed at the beginning of research question three, the Academy structure was focused on equity and inclusion; thus, the classroom cultures in the

Academy were expected to be equitable and inclusive. Given this, I was not surprised when I was unable to find any constraints that directly linked to classroom culture.

Though there were not a lot of identified constraints, participants did have moments where their CEA was enabled and moments where it was constrained, as will be discussed in the next section.

Summary

During the Academy HRE, participants often shared their prior experiences, which were utilized to afford multiple opportunities to further deepen or strengthen their CEA, but there were also moments where CEA development was constrained in the Academy HRE. However, each participant developed their CEA to some extent as described in the vignettes below. I drew upon all the available data sources (individual interview, observations and field notes, photovoice assignments, photovoice focus groups, pre/post-tests, and pre/post-surveys) to develop each participant's vignette.

The Sophomores

Andy. Andy's CEA was most often enabled when he had the freedom to make his own decisions and openly explore his environment. Though his body language in class could have been interpreted as disinterested, he was fully engaged as I often witnessed conversations among his table group where he used the animals to quiz his group members. Not one to ask a lot of questions in class even though he often volunteered to answer questions, Andy actively helped his fellow classmates become comfortable with animals in the classroom and in the field by showing them how to safely handle the organisms. He also usually talked to the animals he captured as he held them for his peers to see. On the post-test, he had a 17-point gain and scored the third highest among the first year participants.

Andy did not appear to have any moments where he was uncomfortable even when he caught the snapping turtle in the trap. He still stepped up to see it and stayed close to Jeff Hall, as he talked about the snapping turtle. Yet, there was evidence of Andy's CEA being constrained when he mentioned in his exit interview that one reason he enjoyed the class was because he would probably never have a class like this again since he planned to be a chemist. Thus, Andy did not seem to envision himself as someone who would spend time looking for herps in the future.

Overall, Andy thrived in the field and seemed to be excited by any type of organism he found. His comfortableness in the environment, use of animals as study tools, and encouragement of others were a few of the factors that led to his CEA development. His background in agriculture (e.g. he discussed his agriculture classes in school) helped him make connections to habitat and environmental issues (e.g. he explained how brush piles were used to create habitat).

Gary. Though Gary was generally a quieter student in class, he did discuss with his group how he noticed many things like lizards and grasshoppers in his yard. He also mentioned the lizards in his exit interview. Like Andy, Gary increased his post-test score by 17 points.

Gary had the lowest CEA score of 3.56. He was one of two students to rate himself a 2 on the post-survey, not feeling like it was possible for him to *talk like a scientist*. On the post-survey questions I coded for CEA, Gary gave himself one 5, which was on feeling like he could *be good at science or a related field*, which seems to contrast with his rating of a 2 for *talk like a scientist*. This rating also seems to contrast with the 3s he gave himself on other questions related to science ability (e.g. *knowledge of science, confidence in doing science, acting like a science person*). His highest principle rating was for principle d (sense of place and discussing environmental issues), as he gave himself a 4 for *interest in nature and interest in taking care of the environment*, which was consistent with his ratings on *connection to nature and connected to living things in your environment* for principle c (critical consciousness of place). His lowest average of 2.67 for principle e (envisioning self or world differently) was the lowest in the class. However, he rated his science ability/interest as 4.0 on the pre/post-surveys.

Gary's CEA was mostly constrained by his view of urban environments and his discomfort with herps. Gary discussed both with his peers in class and in his final interview how he went to his grandparents' house to look for herps because they lived out in the country. While his post-survey results were highest for connections to and interest in nature, Gary saw herp habitat as somewhat limited to the country. Gary was also one of the participants who interacted the least with the animals in the classroom. Though he would hold a herp if one of his classmates encouraged him, he never volunteered to remove the herp from its cage or asked to hold the herp when someone else had it. Similarly, he did not vie to hold herps in the field. His post-survey results also demonstrate how he had varying views of his interest in and ability to do science, which could have also contributed to moments of constraint for his CEA development.

Though Gary had moments of uncertainty during the Academy HRE (e.g. the snake holding vignette), his CEA was most readily enabled through the encouragement of peers, especially Andy, Kimberly, Jasmine, Patrick, Quincy, and Tabitha. He also actively engaged in the photovoice project and shared many photographs of habitat, which seem consistent with his ratings of his connection to and interest in nature (Field note data; pre/post knowledge test data; post-survey data).

Jaylyn. Jaylyn was the male who asked the most questions during class, and his curiosity continued into the field where he continued to ask questions regarding habitat and natural history of captured organisms. He was an active participant during the photovoice focus groups, and he often connected his photographs to experiences from his childhood or to how he was sharing his Academy HRE experiences with his family. Jaylyn did not hesitate to use scientific vocabulary during class, and this was most encouraged by Betty, who also tried to incorporate the vocabulary into her interactions with her peers. Jaylyn's 13-point gain on the post-test was slightly below the class average of 15.84.

Jaylyn, along with Casey (the returning SRA), had the highest CEA score among males in the class, and he had a 0.6 gain in his perceived ability/interest score. He had the highest averages for principles a (deepen understanding) and b (recognition of self as expert), and the only rating apart from a 4 or 5 on these principles was for *using tools*, which he rated a 3. This was consistent with his classroom and field performance in that Jaylyn often watched as others engaged with the organisms and would act as the data recorder rather than directly work with the animal and the tools. Jaylyn also rated his *connection to nature and interest in nature* as 3, which was consistent with his performances in the field in that he and Elaine were the most hesitant in the field. However, his rating for *curiosity about nature* was a 5, which was displayed through his constant questioning.

Jaylyn positioned himself as not an "outdoors" person and not a "herps" person, and this positioning often constrained the development of his CEA. He was scared of most of the animals in the classroom, especially the snakes, and like Gary, he did not take animals from their containers or ask to hold them. He was content to watch others. He also did not talk to the animals like the other participants did. He appeared to be the most uncomfortable in the field, as he was constantly swatting bugs and carefully watching where he stepped. During the University Forest field investigation, he stayed closest to the field when the students explored the forest. Jaylyn also had moments where he referred to finding herps in the country, where he used to live, as opposed to more urban areas like where he lives now.

Jaylyn's CEA was most often enabled by his curiosity. However, his discomfort in the field served to constrain his ability to deepen his critical consciousness of place and sense of place. Yet, he was able to work through his discomfort at times. For instance, once an organism was captured in the field, he seemed to momentarily forget he was in the woods, as he would join the group and begin asking questions about the organisms and its life history patterns. Jaylyn also discussed several instances where he shared his experiences with his family and educated his siblings about herps. Betty and Alicia were

Jaylyn's two most influential peers and with their encouragement he touched and/or held most of the organisms in the classroom and engaged in looking for herps in the field.

Kadence. Kadence came into the Academy HRE enamored with turtles, and during the course, she developed an appreciation for the other herps, as well. Though initially scared of frogs, Kadence learned how to properly hold them in class and then continually tried to capture them in the field. She often talked to the animals both in the classroom and in the field. Partnering most of the time in class with Kamal, Kadence served as the mediator between Kamal and frogs, being the one to hold them so he could observe their features.

Kadence's CEA score was 4.19, and she had no gain in her perceived ability/interest score though she did have a 20-point gain on her post-test. Her highest rating was for principle b (recognition of self as expert), where she rated herself as 5 on three out of the four questions, which was consistent with her rating on feeling like she had the ability to *teach others about herps*. She also rated herself a 5 for increasing her *empathy for animals*, *connectedness to living things*, and *interest in taking care of the environment*. These ratings are consistent with Kadence's actions in the classroom with the animals, as she often touched them and talked to them, and it is also consistent with her newfound awareness of environmental issues at her house (e.g. the oil spills from her grandfather's car). Though she rated her *increased curiosity about nature* at 5, she rated her *connection to nature and interest in nature* at 3. These ratings were also consistent with her performances in the course, especially during fieldwork where she was often more timid at the beginning of the field investigation but became more comfortable in the field as the day progressed. She and Alicia were the two females who asked Dr. T the most questions when they were working in their class groups.

Kadence's view of urban areas was mostly readily displayed during the field investigation at City Park, as she indicated that not finding Box Turtles did not surprise her. However, even though she lived in an urban area, she did take photographs of and talk about natural areas at her house (e.g. photograph of bee in flower). In her exit interview, Kadence positioned herself as not a "science person," but this positioning did not seem to constrain her CEA development. Yet, her hesitations on field investigations did produce moments of constraint as it took her time to adjust to the field conditions; however, once she adjusted she was an active and enthusiastic participant.

Kadence's CEA was most often enabled by her interactions with the animals and her photovoice assignments and discussions. However, like Jaylyn, her discomfort in the field served to constrain her ability to deepen her critical consciousness of place and sense of place. Yet, Kadence exhibited understanding of local environmental issues when she discussed her concern for the oil that leaked from her grandfather's car and how this could affect her local environment.

The Juniors

Alicia. Alicia also entered the Academy HRE with a love for turtles, but her affections quickly extended to lizards, then frogs, and finally by the end of the course she admitted that she even liked snakes. At first, Alicia was more subdued during class than on the field investigations, but after the class on lizards, she began to ask more questions, interact more with the animals, and she transitioned alongside Betty to be a leader in her class group (see Table 4). Her email to me after the lizard lesson confirms this observation.

> Hey Ms. Huffling,
> Thank you for teaching me about lizards. I enjoyed class today especially holding the lizards. I think I fell in love and they are my new favorite reptile. That means a lot because I love turtles! I am interested to see what's to come.
> See you soon,
> Alicia

Holding a snake for the first time was a huge moment for Alicia, and she trembled as she held the snake. The next day when snakes were dissected, Alicia took a prominent role in helping and encouraging others throughout the dissection.

Alicia had the highest score on the post-test (37), and her perception of her science ability increased from 4.2 to 4.8. She also had the highest CEA score in the class - 4.94. She only rated herself below 5 on one question, which was how has participating in the Academy HRE increased *your knowledge of science*, and she rated this as a 4. Alicia's scores are consistent with her performances in class after the lizard lesson. Alicia was the participant who talked most to the animals, with most of the talk describing the animal to itself or asking the animal if it was okay. For example, she often visited the lizards before and after class, and she would tell them what nice claws they had or how their scales were a reptilian characteristic; then, she would make comments like "you are looking nice and green today, Mr. Lizard. I'm glad you're not stressed living here."

However, Alicia distinguished herself from being someone who would study herpetology in the future, and she was quick to tell others that she was going into the health sciences when it was suggested that she could be a herpetologist. Though this did not directly constrain her CEA, it does indicate that she might not have connected the environmental aspects of the class to the health sciences. Alicia most often discussed how teaching people to overcome their fear of snakes and other herps would help herps in her community, and she did not discuss human disturbances unless another participant raised the issue.

Alicia appeared to experience the greatest CEA development, even though it was difficult to truly capture her understanding of environmental issues. She did express desires to take actions (e.g. have her father not kill snakes, save turtles on the road) and she deepened her understanding of natural areas (e.g. why forest fires are needed). Even her reasons for taking the course, which she listed on the pre-survey, indicated her willingness and desire to develop her CEA in that she took the course to spend more time in nature (addresses principles c and d), learn more about herps in general (addresses principle a and b), and conquer her fear of snakes (addresses principle e).

Betty. Betty was the most outspoken of all the participants, often telling stories to the large group, asking questions, and answering instructors' and peers' questions. In the field, she was most engaged when there were animals to be caught. At times when animals were not readily visible, she hung back more choosing not to explore as much as the other participants. In class, she was vital in helping Jaylyn and Alicia develop their CEA, as she encouraged them and constantly told them the herp was not going to hurt them. She also talked to the animals and asked on almost a daily basis if she could get a snake out and hold it.

Betty experienced the highest gain score of 25 on the post-test, and her confidence in her science abilities did not falter, as she again, like the pre-survey, rated herself a 5 on the post-survey. She, along with Tabitha, had the second highest CEA score of 4.88. The only time she rated herself below a 5 was for the question*: to what degree did participating in this HRE make you feel like that you could be good at science or a related field*. She rated this question a 3; this might be partially explained by the fact that Betty already had a high view of her science abilities so her experiences in the Academy HRE did not increase those feelings that much.

Betty's CEA was most constrained when she discussed more urbanized areas, as she did not view them as places for herps. She also talked about human disturbance in more general terms and never gave a specific example from her community during the photovoice focus groups.

Betty's CEA developed the most for principles a (deepened knowledge) and b (recognition of self as expert), as she seemed to immensely enjoy learning about the organisms. Though she, along with Jaylyn, asked the most questions during class, unlike Jaylyn, her questions focused more on the organisms and less on their habitats. She also was not shy in sharing her knowledge of herps and often answered peers questions if Dr. T was busy helping other students. Having the animals in class and engaging with them in the field were the opportunities that seemed to most influence Betty's CEA.

Elaine. Elaine was the quietest participant in the HRE, both in the classroom and in the field. She restricted her social interactions mostly to her group (Jaylyn, Betty, and Alicia) but occasionally talked to Kamal, Kadence, or Andy. In the field, she did not actively explore areas but once an organism was found she would crowd around to hear Dr. T talk about it. She did not try to capture organisms in the field and she did not hold many organisms in the field, but in her interview, she did express how beneficial and informative she found the lesson on frogs.

Elaine had the lowest score for self-perceived science ability/interest of 2.8, which did not differ from her pre-survey rating. She was the only participant to rate herself at 1 for *I think I would be a good scientist* and *I think like a scientist*. However, she did indicate a 4 on the question: *To what degree did participating in this HRE make you feel like it is possible for you to think like scientist*, which seems to contradict the rating of one. With a CEA score of 4.19, Elaine's highest average was for principle c (critical consciousness of place) at 4.67. Her lowest average was for principle b (recognition of self as expert) at 3.5, and she rated herself at a 2 for feeling *like a science person*, which was consistent with how she described herself in her interview. Yet, she did experience a 19 point gain on her post-test, which supported her self-rating of 4.25 for principle a (deepened knowledge).

Elaine's positioning of herself as not a "science person" on both the interviews and pre/post-surveys constrained her CEA development, as evidenced by her lowest ratings for principle b. She was also the participant, who had the fewest displays of expertise during the course, and she was the only participant who chose not to share a story beyond the introductory one Dr. T had the participants share on the first day of class. During the photovoice focus groups, her responses centered on the organisms and educating people about them and did not focus on environmental issues.

Elaine's CEA development was the most difficult to capture given her participation in the course. When she did talk to her peers, the conversations were low and difficult to hear. Her contributions to the photovoice focus groups were also difficult to hear, as she spoke softly and did not look at the camera. Given the data that is available, Elaine appeared to develop her CEA the least of all participants. She was never observed talking to the animals, and though she liked to look at them, she was not keen on holding them. In the field, she was hesitant and more of an onlooker than an actual explorer.

Jasmine. Jasmine was also quiet in class but quite expressive with her table group. She most often talked and paired with Tabitha during the class. In her photovoice focus groups, she, like Tabitha, shared photographs she had framed in specific ways to better convey the message she was trying to make with the photograph (e.g. placing the camera on the ground to capture a herp's perspective of the world).

Jasmine had a CEA score of 4.25, and her highest average was for principle c (critical consciousness of place) at 4.67, which was also reflected in her photovoice participation in that she often discussed potential habitat for herps. Her lowest average, 3.75, was for principle b (recognition of self as expert), which is also consistent with her self-rating of 3.8 for the post-survey science ability/interest score, only 0.2 points higher than her pre-survey score. This was also the only time she rated herself below a 3 for a question, and it was on feeling like *you could be good at science or a related field*, which again paralleled her perceptions of her science ability/interest. Though she had the lowest average on both pre-test and post-test, she did have a gain score of 19 points.

Jasmine's CEA was constrained by her views of urban environments, as she talked a lot about going to her friend's house in the country to take photographs. Like Betty, she spoke about general environmental issues and did not connect the concerns to areas in her community. Though not observed directly during the Academy HRE, her post-survey ratings also suggest that Jasmine's views of her science abilities could have been also been a constraint to her CEA development.

Jasmine's CEA was most encouraged by her interactions with her peers. While Andy and Kimberly often encouraged her to hold organisms or capture them in the field, Jasmine, herself, was a constant encouragement to others, especially Tabitha. She even recognized this in herself and discussed it during her interview. During field investigations, Jasmine actively searched for organisms and appeared to be comfortable in her surroundings.

Kimberly. Though at first quiet, Kimberly quickly became a leader in class as her comfort with animals and prior experiences in nature (e.g. hiking with friends and family on a local trail) enabled her to help and encourage her classmates, who were less experienced than her. She also talked to animals and often quizzed Mary on the characteristics of the organism. Her sharing of stories increased throughout the Academy HRE, as did her asking and answering questions. Living in a rural area provided Kimberly with opportunities outside of the Academy to look for herps, and she often came back from her weekends with new photographs of herps she had seen.

Kimberly's CEA score was 4.19, with her highest average being for principle d (sense of place and discussing environmental issues), which was consistent with her comfort in the field and her stories of sharing with her family. Her lowest average was for principle e (envisioning self or world differently) at 3.67, though she rated the possibility of her *teaching others about amphibians and reptiles* at a 5. She did perceive that her science interest/ability had increased, with the second highest gain score of 0.8. Yet, Kimberly had the lowest post-test gain score (8) of all the first year participants.

Kimberly's post-survey and conversations in class indicated her CEA was most often constrained by her views of herself, as she did not readily identify herself as the "scientist type." She also indicated during a photovoice focus group that she really wanted to learn more about the environmental concerns reptiles and amphibians faced, which indicates she thought she did not know. This was also reflected on her post-survey response as she gave herself a 3 for understanding threats that amphibians and reptiles face. However, she did share her experiences and knowledge with family (e.g. saving a Box Turtle with her dad), and she discussed in her exit interview how she was more aware of "ruined" habitat.

Given Kimberly's background (e.g. spending lots of time outdoors and having pet green snakes as a child), her CEA was most encouraged when she able to help others, be it her family or her peers in the Academy HRE. She, with Andy, helped Gary, Jasmine, Mary, and Tabitha learn to hold the various herps at their table. In the field, she was not afraid to venture off by herself and explore. When in a group, Kimberly often suggested places to look, and she continued to look even when others had stopped.

Mary. Mary's performance in the class was not as consistent as her peers. There were days when she was fully engaged, asking questions and vying to hold organisms once Kimberly or Casey had showed her how, and then on other days, she was withdrawn and appeared more timid around the animals. However, Mary was consistent in her photovoice focus groups in that she readily engaged in conversation, which might be due to her prior interest in photography. She was fully engaged during field investigations and often picked flowers or commented on how beautiful nature was.

With a CEA score of 4.25, Mary's highest averages were for principles c (critical consciousness of place) and d (sense of place and discussing environmental issues), which were consistent with her performance and interactions during the field investigations. In fact, she rated herself a 5 on each question associated with these 2 principles. Her average (3.25) for principle b (recognition of self as expert) was the lowest in the class. Her perceived science ability/interest score increased by 0.2 points from the pre-survey to the post-survey. However, her post-test score increased by 20 points, and she had the third highest score overall and the second highest for first year participants.

Mary's CEA development was most often enabled during the field investigations and the photovoice project. In the field, she helped her group, even capturing a frog though at first she was afraid she would hurt it. She explored on her own as well, though she did not appear to look for herps as much as simply take in the overall landscape and she often said, "the beauty of nature is all around." In class, her CEA was most often enabled through the encouragement of Casey and Kimberly.

Patrick. Patrick asked few questions in the large group setting, but he often asked questions in small groups and his questions were mostly about habitat. Patrick also reflected on habitat photographs during his photovoice focus groups, and in his interview, he discussed how he had discovered that his backyard and community had lots of good habitat for herps. In the field, Patrick actively searched for herps and appeared comfortable in natural environments. When holding animals, he would often hold them close to his face and would whisper to them about how "handsome" they were or how they needed "to be careful out there."

Patrick's CEA score was 3.94, which was surprising given that Patrick made the most connections to historical use of the land by organisms and verbalized how humans lived there now and needed to learn to live with the animals. However, his highest principle average was for critical consciousness of place (principle c), which is consistent with his thoughtful reflections on the environment. Patrick's rating of 5 for feeling *empathy for animals* is also consistent with his conversations with the organisms. His lowest average was for principle e (envision self or world differently), which is consistent with his other post-survey ratings regarding his *knowledge of science, ability to teach others about herps, think like a scientist, and confidence in doing science*. Yet, he rated his perceived ability/interest at 4.4 on the post-survey, and he had a post-test gain of 13 points.

CEA development for Patrick was most likely limited by his conflicting views of himself. As his post-survey results indicate, he sometimes saw himself as able to be successful at science and sometimes he did not. This surfaced in the classroom a couple of times when Patrick would second guess his identification of an animal or would answer a peer's question and then tell them that they might want to confirm with Dr. T.

Patrick's CEA was most enabled by his awareness of his environment. During his first photovoice focus group, he discussed how he started paying more attention to his surroundings after taking the Academy Saturday herpetology course over the school year. He also asked the most habitat-related questions during the course. In the field, he was comfortable and confident, and he asked the most non-related herp questions (e.g. he asked about lichens and how slugs produce slime). He also was extremely careful not to disturb too much of the microhabitat, as he turned over logs and sorted through leaf piles; he seemed determined to leave the area exactly as he had found it.

Quincy. Quincy was the comedian in his group, as he constantly made his peers laugh. He also used this humor when working with the animals, speaking for the animals when they were in the cages. For instance, when he and Patrick were observing a frog in a cage, Quincy, speaking as the frog said, "Oh, Lord. It's those kids again, staring at me. Can't a brother get some privacy?," which elicited a laugh from Patrick. Yet, he also took the class seriously and regularly quizzed his group members on animal identification. In the field, Quincy was determined to capture any herp he saw, and he did not give up even after failing multiple times. He often talked to the animals as he went to catch them (e.g. "Okay, come here little fella").

Quincy had the second lowest CEA score for the group (3.81). Like Patrick, his highest rating was for principle c, critical consciousness of place, which is interesting since he most often explored with Patrick when in the field. His lowest rating was for principle e (envisioning self or world differently), and like Gary, he rated himself a 2 on feeling like he could *talk like a scientist*. Along with Kamal, he also had the second lowest perceived science interest/ability score for the post-survey at 3.6, though this was 0.2 gain from the pre-survey. On the post-test, he achieved a 17-point gain.

Like Gary and Patrick, Quincy had conflicting views of himself on the post-survey, which could have constrained his CEA. He also rarely discussed environmental issues in his photovoice focus group and when he did it was in more general terms about overall human disturbance, with no specific examples given.

Quincy was most often afforded opportunities to exhibit his CEA when he worked with his group in class or was in the field. His interactions with Patrick seemed to push him to consider habitats in new ways, as he responded one time after Patrick's question to Dr. T, "Man, you always get me thinking." His comfort in the field and with the animals also aided his CEA development.

Tabitha. Like Alicia, Tabitha was more subdued at the beginning of the course, but after she experienced success in lassoing lizards, she began to contribute more to whole group discussions and asked to hold organisms. Her increased involvement culminated in the snake dissection when she took a leadership role in her partnership with Jasmine. During her photovoice focus groups, she often discussed small ephemeral pools she had discovered at her house and her friend's house.

Tabitha, along with Betty, had the second highest CEA score at 4.88, and she also had the greatest gain score increase on the post-survey for perceived science interest/ability, which is consistent with how she rated herself for principles a (deepened understanding) and b (recognition of self as expert). Her only ratings below 5 were for *feeling like a science person* and *feeling like one can contribute to science*, which she rated at a 4. On the post-test, she had a gain score of 15.5.

Tabitha's CEA was often limited by not knowing how to reach out to others regarding the development that was planned in her neighborhood, as she was concerned about how it was affecting the habitat for the animals. She even mentioned that she had discussed it with her parents, and they did not really know what she could do either. Tabitha was also the only female who mentioned that herpetology was not normally what girls do, which could have constrained her participation, though observations revealed that her participation in class and in the field increased throughout the course. In her interview statement regarding this issue, it also seemed that she was proud that she was doing something that girls did not usually do, so it could be that this bolstered her CEA rather than constrained it.

Tabitha was the participant who was most aware of specific environmental concerns in her community. Her discussion surrounding the development that would remove the trees bordering her land, indicated her knowledge of local environmental issues as she described in detail how this would cause evaporation from the ephemeral pools to happen more quickly, which would decrease the time they existed, ultimately affecting the animals that bred in them. She also pondered whether the pools would even form if the tree cover were removed, and the land was graded for houses. Her success in class and field investigations enabled her development of CEA (e.g. "I realized I was the one with the snake hook, and I was so ready to catch a snake.")

The Seniors

Barbara. This was the second summer Barbara had taken the Academy HRE class, she, along with Casey, Patrick, and Quincy, also participated in the 2012-2013 academic year-long Saturday class. The summer before Barbara had been instrumental in the class voucher project (a partnership Dr. T established with the state museum of natural sciences for the class to find and provide specimens for the museum that had previously not been reported for the County in which the students resided), often going herping on the weekends with her family and bringing back specimens to the class. Barbara encouraged her younger brother to attend one of the week-long HREs, which he did. In class, Barbara was helpful and encouraging to her peers. Though she sat at a table with Casey (the other second year participant), she walked around during times when organisms were used in the classroom and facilitated group learning, much as Dr. T did. In the field, Barbara was confident and seemed to enjoy exploring on her own.

Barbara's CEA score was 4.44. She rated herself highest on principle e (envisioning self or world differently), consistent with her self-perceived interest/ability score of 5, which was the same for both the pre- and post-surveys. Barbara's lowest average was for principle a (deepening understanding), but it was still above four at 4.25. Barbara had the highest score on the pre-test and had the second highest score on the post-test.

Barbara rarely discussed environmental issues in class or in the field. Though she and Casey did not participate in the second and third photovoice focus groups (as they were working on a documentary film project), she did continue to take photographs, but they were almost always of animals. Though the documentary film was focused on teaching others about herps, the students did not discuss environmental issues in the script. The closest they came to raising environmental issues was near the end of the film when the herps told the Academy HRE students to help them tell others not to harm them.

Casey. Casey was the other SRA for the course, and like Barbara, he had a leadership role in the voucher project the prior year. He often looked for herps on his property, which eventually led to him asking Dr. T if they could do a field investigation at his house. Casey expressed concern on multiple occasions about the clear cutting his neighbor was doing, and he worried that it was displacing herps and would eventually affect his land as the run-off from rain was much more sediment-laden when it entered his pond.

Casey, along with Jaylyn, had the highest CEA score among the male students (4.31), and like Barbara, his pre/post-survey perceived science interest/ability score was 5. Casey's highest averages were for principles a (deepening knowledge) and d (sense of place and discussion of environmental issues). His lowest average was for principle e (envisioning self or world differently) at 3.67; he rated himself a 3 for *think like a scientist* and *talk like a scientist*, which conflicts slightly with his other ratings. He had the second highest pre-test score, only 2 points behind Barbara, but only increased his post-test by 2 points.

Casey's conflicting post-survey scores correlate with class observations. At times, he was extremely confident and would actively facilitate his peers learning, but then there were days where he did not seem as sure and tended to stay more in the background as Dr. T and Barbara went around to groups. Yet, in the field, he never wavered and enjoyed showing the first year students how to identify animals.

Casey's CEA thrived most when he was in the field. His own personal explorations of his property helped him develop a strengthened sense of place, and it made him aware of how his neighbors' actions might affect his land. Being able to bring his classmates to his house also enabled Casey's CEA, as he was excited to give them an opportunity to explore a new natural area and hunt for herps.

Kamal. Kamal was probably the most sociable student in the class in that he greeted and spoke to everyone at least once during class. He was well liked by his peers. Though he was extremely afraid of frogs, he loved snakes, having a pet snake himself, and his comfort level in the field was high throughout the course. During the photovoice focus groups, Kamal talked most often about what he planned to do in the future when he had a house (e.g. have some land, recycle, and try not to use fertilizer). He even mentioned in his interview that he wanted his future children to experience the outdoors.

Kamal's CEA was 4.19, and he rated himself the highest for principle c (critical consciousness of place), which is consistent with his photovoice conversations surrounding how he wanted to continue to do things in nature. Though principles a (deepened knowledge) and b (recognition of self as expert) had average ratings of 4, Kamal averaged a 3.67 for principle e (envisioning self or world differently), but this was consistent with his post-survey perceived science ability/interest score of 3.6. Yet, on the post-test, he had a 20-point gain score and tied Betty and Kadence for the third highest class score.

Kamal's CEA was perhaps constrained by two things: he viewed urban environments as devoid of herp habitat and he did not view himself as a science person. After the first photovoice focus group, Kamal opted to take only photographs during class or on field investigations, as he believed there was not suitable habitat for herps at his apartment complex. Kamal was also the most insistent male participant, in stating his views that he was not a "science person," even though he admitted to loving science shows on TV during his interview, he explained that he was not good at school science, he just "didn't get it."

Kamal's CEA was most enabled by the exploration that occurred in his community. Though never really calling himself a science person, he did envision a future where he had some land, spent time in nature, and provided opportunities for his kids to be in nature, catching lizards and bugs. Kamal never overcame his aversion to frogs, though he did capture one in the field for the group. However, he did enjoy the snakes and lizards, and as he said in his interview, "Reptiles to me just seem more laid back. They're just like I'm just going to soak here in the sun," which is how he had previously described himself earlier in the interview.

Concluding Thoughts

Participants' lived experiences were viewed as *belonging in* the Academy HRE (e.g. storytelling was not only encouraged but became a means of conveying knowledge and experience). As their experiences were leveraged, the participants were able to *broaden* the Academy HRE curriculum (e.g. bioblitz being conducted at Casey's house; student explorations leading to various discussions broader than herpetology like the importance of slugs, and lichen) as well as the practices of field ecologists (e.g. working through environmental discomfort did not occur in isolation, rather, participants were constantly encouraging each other to meet the demands of fieldwork). The Academy HRE, in turn, *enriched* and *empowered* the students' lives (e.g. participants' using the environment as lens to further explore their community and educating others by sharing their Academy HRE experience). Thus, the findings from research question one supported my conceptual framework (see Figure 1) that youths' lives *belong in* EE and that when this happens the ensuing EE curriculum is *broadened*. In turn EE can *empower* and *enrich* youths' lives. This two-fold process was critical to the cultivation of CEA during the Academy HRE.

Throughout the Academy, participants deepened their understanding of herpetology and the practices of field ecology through classroom and field interactions with herps and actively exploring local herp habitat (principle a). There were moments where participants recognized themselves as community, field, and/or herpetology experts and also received recognition from others (principle b). The places where the field investigations were conducted were also central to CEA development in that participants were able to deepen their understanding of local natural areas in their community while deepening their understanding of place, leading to a critical consciousness of their community (principle c). Patrick and Mary exemplified this in that each time they were in the field, they took time to observe and take in their surroundings (e.g. Mary picking flowers, making comments about beauty; Patrick asking the most non-herp questions). Through the field investigations and the photovoice project, participants were able to strengthen their sense of place and engage in discussions about the environment with their peers and those outside the Academy HRE (principle d). Finally, participants were able to reimagine the world as a more just place for herps and other organisms. Much of the photovoice focus group discussions centered on ways to educate family, friends, and community, and participants also discussed how others needed to be educated in their interviews.

Though CEA was cultivated in the Academy HRE, there were instances of constraint as participants continued to view urban areas as devoid of habitat (Gary, Kadence, Kamal, Jaylyn, and Tabitha). Students' views of themselves and/or views of science also constrained CEA as times (Andy, Alicia, Betty, Elaine, Gary, Kamal, Kadence, Kimberly, Jaylyn, Jasmine, and Patrick). Finally, not having a deep understanding of local environmental issues and not knowing how they could make a difference also constrained participants' CEA, as they sought opportunities to apply their newly acquired knowledge of herpetology.

Overall, exploration, decision-making, and "second chances" were prominent themes that enabled CEA. Being able to explore in the classroom (e.g. observing, touching, holding herps) enabled participants, who were more comfortable with animals (Andy, Kamal with reptiles, Kimberly, Casey, Barbara, Patrick, and Quincy) to facilitate and encourage the learning of others (Alicia, Betty, Elaine, Gary, Jaylyn, Jasmine, Kadence, Mary, and Tabitha) as they helped them to become comfortable with the organisms. Field explorations (e.g. searching, finding, and capturing herps) in the local community and the photovoice project also enabled CEA by providing participants with opportunities to decide where to search, how far to venture into the forest, and how to best represent their communities' strengthens and weaknesses. There were multiple "second chances" for participants as animals were constantly present in the classroom and field investigations and photovoice focus groups occurred weekly. The Academy HRE not only enabled those students with more experience in nature and with herps to further develop their CEA but it also removed barriers for the other students by helping them to come to see themselves as "herps people" and "outdoors people."

Given my findings, CEA appears to offer a robust framework with which to study EE programs and in turn the research stands to inform environmental educators about the kinds of components that are critical to incorporate when a goal of the program is to assist others in developing their CEA.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

In this chapter, I first provide a summary of the findings. Then, I discuss the contributions of these findings to environmental education (EE) research on environmental literacy, equity and identity, and place. Next, I discuss implications for researchers, who want to use Critical Environmental Agency (CEA) as a framework to examine EE settings. Finally, I discuss implications for educators, who are interested in providing EE learning opportunities for students.

Summary of the Findings

This study describes a theoretical construct, CEA, a new framework for EE research that was adapted from Critical Science Agency (CSA) work in science education (Calabrese Barton & Tan, 2008; Tan & Calabrese Barton, 2010; Tan et al., 2012) and work on critical consciousness of place in EE (Greenwood, 2012; Gruenewald, 2003). Given that CEA is a new construct that I am proposing for use in EE research, my study examined how CEA was enabled and constrained for diverse youth, who were part of a field ecology program, focused on herpetology. An additional purpose of this study was to examine how youth were encouraged, invited and enabled to share their experiences and how these experiences enriched the month-long herpetology course leading to deeper development of CEA.

The findings from this study inform our understanding of how diverse youth engage in EE, develop environmental and science identities, and strengthen their CEA. The findings also inform our understanding of obstacles that hinder youths' CEA development.

The Academy HRE instructor readily invited participants to both share their experiences and use their prior knowledge and expertise to help other participants. For example, when students had prior experience, Dr. T often placed them in positions of leadership, such as assigning them to lead groups, both in the classroom and in the field. Participants' experiences were also woven into the structure and curriculum of the class, as Dr. T remembered stories that had been shared and used this information to further develop the course. Participants also recalled each other's stories and often referred to them when similar experiences were presented in class.

CEA was enabled through multiple opportunities participants had to enact and take up the five principles of CEA. Throughout the course, participants were able to deepen their understanding of herpetology by participating in classroom activities and field investigations. Field investigations offered participants opportunities to engage in the practices and modes of inquiry of field ecologists (principle a). The classwork and fieldwork provided opportunities for participants to engage with live amphibians and reptiles, which prompted students to begin to use animals as study tools to learn identification skills. This led to participants asking questions about habitat, behavior, and life history patterns and fostered discussions of environmental concepts, such as deforestation and habitat fragmentation. Participants also established their developing herpetology expertise as they recognized times when they accomplished what others could not (principle b). Others also recognized the participants as people who knew about and understood herpetology (e.g. Kamal educating people about lizards at his church).

Place was central to the Academy HRE, as three out of four of the field investigations were located in the county in which all participants lived. Participants readily made connections to these places, which enabled them to deepen their understanding of place. This deepened understanding of place led to the participants developing a critical consciousness of place (principle c), as they realized how lands in their community had been disrupted and began to consider ways they could educate others about how to appreciate and protect the land. As participants developed their critical consciousness of place, their sense of place was strengthened (principle d). Participants developed their place identities and place attachments as they explored their community. For instance, when on the bioblitz field investigation at Casey's house, Gary remarked to Andy, "This is cool because it is like where we live. We are representing our county."

This strengthened sense of place fostered conversations and moved the participants toward thinking about and planning how to educate others. It also enabled the participants to begin to take actions that they felt were more environmentally responsible. For instance, Kimberly during a photovoice session commented, "I am always surveying the road now looking for animals to rescue. I even have my family helping me." Mary also shared an observation she made about her community with one of the international students during class.

> Mary – I was at the outdoor shopping center this weekend, and I could not believe that I couldn't find somewhere to recycle. I had been there hundreds of times, but it never crossed my mind to recycle. I would just throw my bottle in the trashcan, but after you showing me the photos of the Pacific Ocean trash pile, I didn't want to throw it in the trash. I ended up taking it with me. (Field notes, 6/28/13)

Mary's comment highlights how the participants began to envision what they considered a more just world (principle e) and often discussed how to help others learn to understand and empathize with amphibians and reptiles as they were learning to do.

Though each participant was able to engage and develop her CEA, there were times when CEA was constrained as participants struggled with their perceptions of urban environments, themselves, and science. Though participants acknowledged seeing herps in urban areas, they had a hard time associating urban areas with potential habitat for herps. This point of view surfaced most often during the photovoice focus groups, as participants would explain that they did not have habitats for herps at their homes. This constrained CEA because most of the time participants did not connect urban areas to areas that could and should be protected; instead, they tended to focus on more rural environments as those that needed habitat protection. Some participants also struggled with how they saw themselves in relation to herpetology and science, positioning themselves as not a "herps or science person," which constrained CEA in that they wavered on whether they recognized themselves as having expertise in herpetology or not. This is not uncommon to identity work, as Carlone et al. (in press) also observed this fluid movement in participants' identity boundary work in the 2011 Academy HRE. This supports the need for longitudinal studies to help us better understand how the Academy HRE affected students.

Since CEA was developed by synthesizing literature on CSA, critical pedagogy of place, and sense of place and this was the first study to use CEA as a theoretical framework, questions arose as to how this model fared with empirical use. Did the model work; did the model offer an appropriate framework to analyze data collected? After testing the model, does it need to be tweaked and if so, why and how?

The model did enhance, I believe, my interpretations of the empirical findings especially in regard to principles a (deepen understanding), b (recognize self as expert), and c (develop critical consciousness of place). Though principles a and b are both important in CEA and CSA, principle c, for this study, was the critical principal, which determined how participants developed and engaged their CEA.

This was an exciting find as I had wondered, prior to the empirical research, if participants would be able to develop their critical consciousness of place in such a short time frame as it takes time to reflect on, reconsider, and refocus how one understands the places that one inhabits.

Principles d (sense of place and discussion of issues) and e (envision self and world differently) were the most difficult to capture in this study. This was mostly due to types of questions asked during the interviews and photovoice focus groups as these questions did not directly attempt to assess these principles. Therefore, more inferences had to be made when interpreting participants' meanings when these two principles were considered. For example, when participants discussed a place and how it reflected their community, I assumed this was an example of their place attachment and place identity; and, when participants discussed educating others to help local herp populations, I assumed the participants were envisioning a more just world for herps. In the future, I hope to develop more robust interview questions that can more directly address these two principles.

In regards to tweaking the CEA model, my initial conceptual framework (see Figure 1) is too static a model and does not display the intricate interactions that occur between and within the separate principles. As discussed previously, I found it difficult to tease apart the separate principles as the lines often blurred and multiple principles were at work in any given point within the data. Therefore, the model needs to be understood as a dynamic concept that is interwoven and fluid with participants continually moving within and between principles. The arrows on my original model only point in one direction, but as I analyzed the data I realized there is continual feedback loop between all of the principles; as participants are shaped by one principle they were also changing in response to other principles. My analysis of data supports CEA as a theoretical framework and as CEA is used in additional empirical research, the model will continue to be refined to further our understanding of how people develop CEA.

Contributions to EE Research

I believe this study has implications for several areas of research, including environmental literacy, equity and identity, place, and field ecology in EE. In the following sections, I will discuss how this study contributes to these areas.

Environmental Literacy

Though environmental literacy was not the central focus of this study, I believe there are implications from my study that can be applied to environmental literacy and contribute to environmental literacy research. Considering NAAEE's (2011) four principles of environmental literacy ((1) knowledge and understanding of environmental concepts, problems, and issues; (2) cognitive and affective dispositions; (3) cognitive skills and abilities; and (4) appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts), my study found that participants were able to deepen their environmental literacy through the development of their CEA. First, participants deepened their knowledge and understanding of EE through interactions with organisms, explorations of natural areas, and consideration of their communities' strengths and weaknesses in regards to habitat for herps. Second, participants developed empathic dispositions toward organisms, felt a personal responsibility for taking care of the environment, and were motivated to educate others (NAAEE, 2011). Third, participants deepened their cognitive abilities by learning about and engaging in practices of field ecologists, as well as deepened their understanding about and connections to local places. Finally, participants indicated they were more aware of environmental concerns in their community and considered ways that these concerns could be addressed.

In addition to qualitatively assessing participants' environmental literacy development per the NAAEE standards, Chambers and Radbourne (2015) discuss how students can develop critical literacy skills by engaging in EE. In particular, they highlight *questioning, visualizing, and synthesizing* skills that their participants developed.

My study also supports the generation of these skills as participants comprehended the environment and the organisms by generating *questions* before, during, and after the field investigations (Hasset, 2008). Participants *visualized* or created images from experiences when they imagined how the world could be a more just place by educating their community about herps, which they believed would help to mediate environmental concerns that herps faced, such as deforestation and destruction of ephemeral pool habitat. Finally, *synthesizing* occurred as participants created original insights and perspectives of their photovoice assignments and merged this newfound awareness of the environment with their existing ideas about their community.

By broadening their CEA, participants also developed multiple aspects of environmental literacy. However, it should be noted though that while this study captures the month-long experiences of 16 high school students, I am not attempting to make any claims regarding the long lasting impacts of the program. Yet, in this brief snapshot of time, participants' acknowledge that their thinking about their environment and community had changed, so the question then becomes how enduring was this change. Thus, my plans for future research include further interviews with my participants in order to collect the longitudinal data needed to gauge the persistence of this change.

CEA is a framework, which can be used to qualitatively assess environmental literacy development. Qualitative indicators of environmental literacy are needed to complement the recent work on the development of quantitative measures of environmental literacy (NAAEE, 2011). Though quantitative measures do provide information about what types of students are succeeding or struggling with environmental literacy, they do not tell us how students develop environmental literacy, which is why qualitative research needs to be conducted. Thick, rich descriptions of how students develop environmental literacy will better enable researchers and practitioners to understand and develop programs that result in a deeper understanding of environmental literacy.

Equity and Identity

This study also has implications for equity and identity research in EE. As detailed in my literature review, the research on diverse youths' engagement with EE is scarce. For instance, the NAAEE international research symposium now has a strand for research on underserved populations. Thus, given the diverse background of my participants (see Tables 2 and 3), this study adds to the understanding of how underrepresented youth engage in EE as well as presents ways that their participation was enabled and constrained.

As discussed in Chapter 2, sociocultural identity studies by equity science education scholars have added greatly to the understanding of underrepresented youths' views of science and of themselves as "science people." Yet, the history of identity studies in EE is steeped in a psychological perspective (Stets & Biga, 2003). Recently, there has been a move toward using a sociocultural framework to study environmental identity development in EE (Blatt, 2013, 2014). However, as Stapleton (2015) attests, most of these studies have only focused on environmental identity development in relation to the natural world and have not attended to social relationships and recognition.

Therefore, this study contributes to the growing body of sociocultural identity studies in EE and is unique in that I address both how the participants' relationship to nature and social interactions contributed to their continued environmental identity development and development of CEA. Again, I am not making claims that these students' environmental or science identities were cemented, as identities are fluid and malleable over time (Gee, 2001; Wenger, 1998). It should also be emphasized that there were instances (e.g. understanding of urban areas; positioning of self) when the participants' environmental identity development was constrained; thus, identities are continually beginning shaped and reshaped. As a beginning equity and identity scholar in EE, my hope is that by better understanding how underrepresented populations engage in EE and come to recognize themselves as environmental people, equitable learning spaces can be constructed and equitable practices can be employed.

Place

Another area of research where this study has implications for additional inquiry is in place research. There is a wide spectrum of research on place in EE from place-based pedagogy to connectedness to nature to sense of place (Greenwood, 2012; Gruenewald, 2003 Kudryavtsev et al., 2012). Thus, there are two specific lines of place research to which this study contributes.

First, this study utilizes critical consciousness of place as one of the principles of CEA. The *International Handbook of Research on Environmental Education* (Stevenson et al., 2012) suggests that critical consciousness of place is an area where empirical research is needed. The findings from this study demonstrate that participants were able to develop their critical consciousness of place by using the environment as a lens to discover and rediscover herp habitat in their communities. Additionally, participants began to find the inherent beauty and fragility in nature, which led them to consider how human disturbance altered the animal's habitat making it difficult for the organism to survive.

Second, this study contributes to sense of place research through the use of a critically-oriented sociocultural perspective, whereas most studies are conducted from a psychological perspective (Kudryavtsev et al., 2012). Place attachment and place meaning were developed as the collective group spent time together outdoors exploring local environments as well as through individual and family exploration when the participants went home on the weekends. Finally by focusing on youth, this study fills a gap in the literature as most sense of place studies are focused on adults (Briggs, Stedman, & Krasny, 2014) who utilize the environment in their professions (Worster & Abrams, 2005).

Field Ecology

The final area where this study has implications is research on field ecology. As Korfiatis and Tunnicliffe (2012) attest, field ecology is not privileged in the K-12 curriculum. Yet, studies on field ecology courses have demonstrated university students' increased interest in science, increased environmental awareness, increased creativity, and increased ability to work in adverse conditions (Alagona & Simon, 2010; C. D. Allen, 2013; Bowen & Roth, 2007; Brodman, 2000; G. W. Scott et al., 2012; Sukhontapatipak & Srikosamatara, 2012). With this evidence, it would seem K-12 students would also benefit from engaging in field ecology. However, most studies have focused on post-secondary students. Thus, this study adds to the literature base as it focuses on high school students' engagement in field ecology.

This study also provides evidence for student engagement in field ecology as providing opportunities to take up the practices of field ecologists. Participants engaged in community building through storytelling; they also shared knowledge and expertise through their stories. They had to work through uncomfortable field conditions (e.g. when it rained heavily during the bioblitz), and they had to learn to survey the land and discover prime areas for herps. They had to make decisions about where to look for herps and for habitat (e.g. the photovoice project and the bioblitz) without direct supervision. Each of these practices reflects what field ecologists must learn to do. Thus, the findings from this study support the argument that the practices of field ecology are more readily accessible to students (Bowen & Roth, 2007; Korfiatis & Tunnicliffe, 2012), as participants had multiple opportunities to engage in and enact field ecology practices. In addition, this study provides thick, rich descriptions of diverse youths' engagement in field ecology and adds to the work by Carlone et al. (in press; in process) by examining how CEA was afforded and constrained.

Implications for Researchers

The findings from this study suggest areas for future research on CEA, environmental literacy, equity and identity, and place in EE.

Since I developed the construct of CEA and this is the first study to explore CEA development, CEA needs to be examined by the larger EE community. Further studies of

CEA need to address its ability to be used as a theoretical framework and explore its potential as well as it shortcomings, as no theoretical framework can be used to examine all parameters within a setting. Furthermore, research incorporating students' figured worlds (Holland et al., 1998), students' funds of knowledge (Gonzalez, Moll, & Amanti, 2005), and macro-level and micro-level structures (Carlone, 2012) should be conducted. Finally, longitudinal studies need to be conducted to examine how CEA develops over time and what structures support and thwart a student's continued development.

In regards to environmental literacy, the connections between environmental literacy development and CEA development need to be further explored. First, environmental literacy researchers need to consider more facets of participants' environmental literacy. In what ways other than pre- and post-assessment can environmental literacy development be documented? What do students know and believe about the environment that cannot be captured by standardized testing? Conducting more qualitative based assessments such as individual interviews, writing prompts, and assignments like the photovoice project discussed in this study regarding students' views on environmental issues would assist researchers in understanding participants' environmental literacy.

As mentioned previously, there have been limited studies in EE using a sociocultural view of identity as well as studies examining underrepresented populations. Much research needs to be done to determine what structures and practices promote environmental identity development. Also, researchers need to understand how underrepresented populations come to participate in and affiliate with the environment.

Over the past decade, NAAEE (2007) has purposefully sought to broaden its member and participant base and most recently has developed a draft of diversity principles in order to promote diversity, equity, and inclusiveness within the organization and in its public endeavors (NAAEE, 2014). Thus, questions regarding access to greenspaces, natural areas, and informal and formal EE programs need to be explored. Research on informal science programs that provide participants with repeated exposure to natural areas with the purpose of contributing to science need to be explored. EE researchers also need to examine the identity and equity literature base in science education and look for additional frameworks that can be used in EE. Most recently, Wals, Brody, Dillon, and Stevenson (2014) called for collaboration between environmental educators and science educators through research on citizen science programs. Field ecology offers opportunities for students to engage in such programs and is an under researched area of science education (Korfiatis & Tunnicliffe, 2012) and EE research (Barnett et al., 2011).

There are also implications for place research. More studies need to be conducted to examine how people develop their critical consciousness of place. In particular, studies involving K-12 students are needed to understand how children's experiences can lead to development of this critical awareness. Finally, research on student social groups needs to be conducted. How do social groups develop and assign place attachment to natural areas? How do social groups assign meaning to natural places and how do members of the group come to know these meanings? As researchers consider sense of place from a sociocultural perspective, participants' experiences, social groups, and cultural heritage need to be considered.

Implications for Educators

By incorporating students' experiences and privileging their communities as places worth exploring, researching, and protecting, educators invite students to join them in the learning process. Engaging students in EE is of paramount importance, as human consumption of natural resources continues to escalate, which is bringing attention to the need for green technology and green solutions. Thus, the findings from this study are important to both formal and informal educators.

The findings from this study reveal that students need opportunities to explore local natural areas. This is increasingly important in urban areas, where underrepresented populations have less access to green and natural spaces (Cilliers & Siebert, 2011; Iverson & Cook, 2000; Pauleit & Golding, 2005; Tratalos, Fuller, Warren, Davies, & Gaston, 2007). However, exploration alone is not enough. Students need to understand that their community has inherent environmental value. Having students specifically look for environmental strengths, as in photovoice, can foster students' connections to nature.

In addition, the findings from this study revealed that students desire to see and experience what they are learning. Having animals in the classroom or visiting a local stream enables students to connect their learning to tangible objects that they can touch, see, hear, and smell. The participants in this study readily used the animals in the classroom as study tools, and the cameras provided a way for students to document their learning and the photographs became study tools in themselves.

Students in this study also continually discussed how they were making real contributions to science, so their learning had greater meaning, beyond knowing it for the test. Rather, the students were able to connect what they learned in the classroom to what field ecologists do. By contributing to ongoing scientific investigations, students came to see a purpose for learning herpetology and how their learning connected to their lives outside the classroom. Field ecology investigations of local school grounds and/or community open areas can help develop students' understanding, and enable them to make connections to why learning the material matters, and provide opportunities for them to do science and to contribute to science. Additionally, scholars have argued that incorporating field ecology into K-12 classrooms provides a contrast to the stereotypical rigid and highly structured laboratory sciences, which presents students' with a limited understanding of the nature of science (Bowen & Roth, 2007; Korfiatis & Tunnicliffe, 2012). If our desire is to encourage students' CEAs, then we must provide opportunities for them to do so.

Finally, the findings from this study emphasize the instructional value of the research assessments (surveys, tests, photovoice focus groups, and interviews). These data collection methods prompted the students to engage in further reflection beyond that required of the course. Through this additional reflection, participants were able to make connections to what they were learning in class to their own experiences and to their larger community. Thus, there is tremendous value in educators engaging in research in their classrooms either through partnerships with university researchers or through action research projects of their own.

Conclusion

Our environment has, is, and will continue to change. However, human activities are greatly accelerating these changes. Bearing this in mind, EE strives to "teach children and adults how to learn about and investigate their environment, and to make intelligent, informed decisions about how they can take care of it" (NAAEE, 2011). As with other areas of education, EE struggles with issues of equity in that not all people have access to natural areas or EE programs. Thus, it is important for the field to understand how underrepresented populations experience and participate in EE.

Using an equity and identity framework in science education, CSA (Calabrese Barton & Tan, 2008; Tan et al., 2012), I have developed a new framework for EE, CEA, to study issues of equity and identity through the lens of CSA while also attesting to how critical consciousness of place (Greenwood, 2012; Gruenewald, 2003) aids in environmental identity development, and I have used CEA to explore a month-long residential field ecology program, focused on herpetology. I have outlined how participants' experiences were leveraged to develop their CEA, and I have explored how CEA was enabled and constrained in the Academy HRE.

The goal of this study was to expand what it means for underrepresented populations to participate in EE. Through developing their CEA, participants were able to: (a) deepen their understanding of herpetology and the practices of field ecology through interactions with animals and explorations of local natural areas; (b) recognize themselves and be recognized by others as community and herpetology experts; (c) deepen their understanding of place while developing a critical consciousness of their community; (d) strengthen their sense of place in their community and engage in discussions about the environment; and (e) reimagine the world as a more just place for herps and other organisms. Many began to see themselves as a “herps person” and/or “outdoors person” and moved toward action through educating their families and friends and envisioning ways to educate their broader community. Though environmental issues are complex, and long-term solutions are needed, CEA offers opportunities for students to act upon, even if in small ways, what they come to see as important for their community’s environmental well-being.

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APPENDIX A

MODIFED *SHOWED* PHOTOVOICE PROTOCOL FOR ACADEMY HRE

(Modified by Lacey Huffling and Terry Tomasek from Wang et al. (1998))

1.) What do you **see** here?

2.) What is really **happening** here?

3.) How does this relate to you, your community, or herps? (This item as been the most modified for this particular study. In the original study, this question was how does relate to **our** lives?)

4.) **Why** does this situation, condition, or strength **exist**?

5.) How can we use this image to educate others? (This item was added for this particular study.)

6.) What can we **do** about it?

APPENDIX B

PHOTOVOICE HOMEWORK ASSIGNMENT

(Created by Lacey Huffling and Terry Tomasek)

Your objective is to take **6** photos this weekend while you are at home. By class time on Monday, you should have selected your best and favorite photo to print in class. Do NOT delete any of the 6 photos because you will upload all 6 photos to a laptop.
Ideas for Photos:

- Places in your community where you might find herps
- Photos of any herps you find
- Environmental concerns/places affected by humans in your community
- A place in your community that makes you feel like you are in nature
- Something outdoors in your community that you find curious
- Something outdoors in your community that you find beautiful

Remember to ask yourself:

1.) What is my purpose for taking this photo?

2.) Who is my intended audience?

3.) What is my call to action?

APPENDIX C

HRE PRE-SURVEY

(Designed and Modified by Heidi Carlone and members of The Herp Project)

Pre-Survey of Science Attitudes, Interests, and Experiences

Your Name ________________________________**Rising Grade level:** __________

HERP Project Location (please circle one): CCR   Academy HRE   Rockfish

Background: Check all that apply. You can check more than one.
- ❑ African American/Black/African
- ❑ American Indian
- ❑ Latino/Hispanic (Mexican, Cuban, South American, Puerto Rican, etc.)
- ❑ White/Caucasian/European/European American
- ❑ Asian/Asian American
- ❑ Hawaiian/Native Hawaiian
- ❑ Pacific Islander/Pacific Islander American
- ❑ ___________________________Please list any other ethnic background that applies

How would you describe where you live? (Check one)
- ❑ Rural area ("in the country")
- ❑ Suburban area ("outside of the city" or "not quite in the country")
- ❑ Urban area ("in the city")

If none of the above describe where you live, how would you describe where you live?

____

Part I. Your previous science experiences

<u>Before</u> taking part in this herpetology research experience, have you ever: (Check either the "yes" or "no" box for each row)

	Yes	**No**
1. Attended a special science program?	❑	❑
2. Taken an extra school science class in the summer (not a make-up class)?	❑	❑

3.	Participated in a science fair?	❏	❏
4.	Participated in a science club or science team?	❏	❏
5.	Received an award or special recognition for doing well in your science classes or other science-related activities (like a science fair, competition, etc.)?	❏	❏
6.	Worked on a science project or experiment in a university or professional lab?	❏	❏
7.	Had a teacher who made it exciting to learn science?	❏	❏
8.	Had a teacher who made you dislike science?	❏	❏

9. Do you have any hobbies that you consider to be science related? ❏ Yes ❏ No

10. If you answered YES above, please list these science-related hobbies.

___

___

Before taking part in this herpetology research experience, did you ever do any of the following activities for fun or for other reasons that are not related to school? (Check one in each row)

	Yes, I did this before I participated in the HERP Project	**I used to do this when I was younger, but I don't do it anymore.**	**I've never done this.**
9. Read books about science or science fiction	❏	❏	❏
10. Took care of or trained an animal	❏	❏	❏
11. Visited a zoo, aquarium, science museum or planetarium	❏	❏	❏
12. Talked with friends or family about science	❏	❏	❏
13. Spent time outside in nature	❏	❏	❏
14. Looked up science information in the library or on the Internet that was not required for school	❏	❏	❏

15. Walked or hiked in the dark	❑	❑	❑
16. Traveled outside of your community for significant amounts of time	❑	❑	❑
17. Cooked	❑	❑	❑
18. Used special science equipment (telescope, microscope, chemistry kit, magnifying lens, etc.)	❑	❑	❑
19. Made models (airplane, dinosaur, house, etc.)	❑	❑	❑
20. Held a reptile or amphibian	❑	❑	❑
21. Used tools to build things	❑	❑	❑
22. Collected rocks, butterflies, insects, or other things in nature	❑	❑	❑
23. Took things apart (like motors, computers, toasters, etc.) to see how they work	❑	❑	❑
24. Designed web pages	❑	❑	❑
25. Wrote stories about science or science fiction	❑	❑	❑
26. Hunted or fished	❑	❑	❑
27. Went camping	❑	❑	❑
28. Looked at the stars, moon or planets	❑	❑	❑
29. Watched weather or storms	❑	❑	❑
30. Studied the clouds	❑	❑	❑
31. Raised a farm animal	❑	❑	❑
32. Grew vegetables or plants	❑	❑	❑
33. Visited lakes, ponds, or streams	❑	❑	❑
34. Waded or swam in a lake, pond, river, or stream	❑	❑	❑
35. Worked outdoors	❑	❑	❑
36. Collected wild berries, fruits, nuts, or leaves for food	❑	❑	❑

37. Attended outdoor gatherings	❏	❏	❏

Part II. Your views about science

How much do you agree or disagree with the following statements? (Mark one in each row)

	Strongly Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Strongly Agree
38. I think science is interesting.	❏	❏	❏	❏	❏
39. I am good at science.	❏	❏	❏	❏	❏
40. I think I could be a good scientist.	❏	❏	❏	❏	❏
41. Scientists spend most of their time working indoors or in labs.	❏	❏	❏	❏	❏
42. Scientists have a chance to make a difference in the world.	❏	❏	❏	❏	❏
43. Scientists can’t be religious	❏	❏	❏	❏	❏
44. Scientists don’t have many other interests.	❏	❏	❏	❏	❏
45. There are lots of jobs available in science.	❏	❏	❏	❏	❏
46. Scientists have to work hard.	❏	❏	❏	❏	❏
47. Science is a highly respected career.	❏	❏	❏	❏	❏
48. Science is	❏	❏	❏	❏	❏

important to me.					
49. You have to be a genius to be a scientist.	❑	❑	❑	❑	❑
50. Scientists have to go to school for many years.	❑	❑	❑	❑	❑
51. Scientists are mostly White	❑	❑	❑	❑	❑
52. Scientists spend most of their time working by themselves.	❑	❑	❑	❑	❑
53. I think like a scientist.	❑	❑	❑	❑	❑
54. The media (television, movies, etc.) makes science seem cool.	❑	❑	❑	❑	❑
55. Scientists make a lot of money.	❑	❑	❑	❑	❑
56. Scientists are mostly men.	❑	❑	❑	❑	❑
57. Scientists do not have many friends.	❑	❑	❑	❑	❑

58. Consider these individuals in this list below. Who are the THREE individuals who <u>most influenced your interests in science</u>? Write your top three choices, in rank order, to the right.

Mother	**Three most influential people on my science interests (from choices on left)**
Father	
Sister/Brother/Other family member	#1:
School science teacher	
Leader/teacher of other after-school or	

summer science experience	
Clergy	#2:
Friends	
Older community member	
TV Personality (Write the name of the person here): ______	#3:
Other: (Write name of the person here): ______	

Part III. School and School Science

What were your grades for <u>all of your classes</u> this year in school? (Mark one)

❑ Mostly A's
❑ Mostly A's and B's
❑ Mostly B's
❑ A mix of A's, B's, and C's
❑ Mostly B's and C's
❑ Mostly C's
❑ Mostly below C's

What was your final grade (average) in <u>MATH</u> class this year? (Mark one)

❑ A ❑ B ❑ C ❑ Below C

What <u>MATH</u> class did you take this past year?

______

Which <u>SCIENCE</u> class(es) did take this past year (not including health classes)?

______

What was your final grade (average) in SCIENCE class this year? (Mark one)

❑ A ❑ B ❑ C ❑ Below C

Part IV. Why did you choose to attend the Herpetology Research Experience?

______

______

______

Thank you for taking this survey! We appreciate you participating in this study. ☺

APPENDIX D

OBSERVATION PROTOCOL

(Created by Lacey Huffling, based upon Spradley (1980))

C**ollect data about**:

- What are the participants doing?
  - Who is involved? When is it happening? Where is it happening?
- What are the participants saying?
  - Who is involved? When is it happening? Where is it happening?
- What are the participants producing?
  - Who is involved? When is it happening? Where is it happening?

Questions to consider:

- How is expertise being determined? Who determines it?
- How are the participants demonstrating expertise?
- When do the participants demonstrate expertise?
- How is the level of understanding being assessed?
- What are the participant meanings of social change/action?

APPENDIX E

ACADEMY HRE INTERVIEW PROTOCOL

(Created by Heidi Carlone and The HERP Project Educational Research Team)

(Some questions used across HREs and some used only at Academy HRE)

Information for the interviewer: This protocol should last about 25-35 minutes. Please try not to have the interview go beyond 40 minutes, if possible! This is a narrative protocol—designed to get the participants telling stories about their experiences. Try not to lead participants in a particular direction. Your probes should be open-ended, designed to elicit more information about what they are telling you. For example, "Tell me more about that?" "What do you mean by that?" "Can you give me an example of that?" "When did that happen?" "How did you feel about that?" If they want to go on and on about a story they're telling you (related to the prompt you asked), then let them keep going. *It's ok if you don't get through the entire protocol in 45 minutes!*

<u>**Introduction to the research participant**:</u> Say something like: "I want to talk with you so that I can learn more about your thoughts and feelings about the herpetology research experience (hereafter, HRE) you participated in and about science in general. This interview is a little different in that I'm not going to ask you a TON of questions, but I want you to tell me as much as you want to say about each question. It's kind of like the "storytelling". So, sometimes I'll ask a question, and you may talk for as long as 5-10 minutes just on that one question. I am recording our conversation so that I do not miss anything important. Is that ok with you? Do you have any questions before we begin?"

I. Descriptions of Self (This should be short) (3 minutes tops)

1. What were you like during the HRE? Describe **yourself** during the herpetology research experience. (This is a narrative explanation).
   - Get students to explain why they'd describe themselves that way and/or to give examples.

2. Is this the same as or different from how you'd describe yourself during school science? Explain.

Part II. Eliciting Stories (20 minutes)

(You may want to tell the youth that this is the part of the interview where they can expand on their answers in any ways they see fit. This is an open-ended protocol. Let them tell their stories and probe with open-ended responses like, "Can you give me an example of that?" or "What do you mean by that?" or "How so?" or "Why?" or "Tell me more about that". Find ways to draw out their stories. Try not to lead them to give you "good" stories or "stories of success" or "bad" stories or "stories of woe." Your job is to elicit stories that help them express their experiences and their meanings of their experiences.)

3. Tell me about a "**Wow moment**" you had during this course. This would be a moment that **you feel that you won't ever forget**. (If they still are uncertain, you could explain-- This would be a moment where you were surprised, or wowed, or awed. It could also be kind of like a jaw-dropping moment.)

- Describe the moment in detail—what happened? Who were you with?
- Why was that WOW moment for you?
- Did you have any other moments like this? (Depending on time, ask for another quick example or two).

4. Tell me about a HERPS activity (from this HRE) where you felt particularly **good about yourself**. (This would be something where you felt really, really good about what you did or even proud of yourself.).

- Describe that project/activity (What did you do? Who did you do it with? Where?)
- Why did that project/activity allow you to feel proud of yourself?
- Did you have any other similar moments? (Depending on time, ask for another quick example or two).

5. Tell me about a moment **where you really felt "sciency"** during this HRE. This would be a moment where you felt like you were doing science.
(*I don't really want to use the word "scientist" here. I want to keep it super informal b/c some may see "scientist" as distant from who they are or want to be*).

- Describe the moment in detail—what happened? Who were you with?
- What was it about that moment that made you feel *sciency*? (or feel like you were doing science)?
- Did you have any other of those kinds of moments? (Depending on time, ask for another quick example or two).

6. Tell me about a moment where you felt like you were **truly learning about animals and/or their habitats and/or their population**.

- Describe the moment in detail—what happened? Who were you with?
- What was it about that moment you think will "stick" in your memory?

III. Reactions to Specific Activities (10 minutes)
In the next part of the interview, I want to get your reactions to some of the activities you did this week. Describe the activity to me as if I did not really know much about the activity—as if I were a friend or relative.

7. Tell me about your **favorite field experience** at the HRE. (Remind them of choices—snakes, Box Turtles, aquatic turtles, stream salamanders, ephemeral pool (CCR), lizards (RF), and frog call (CASP))

- Get them to describe the activity first without any probes. If you need probes, ask:
    - Why was that your favorite experience?
    - If I were a friend or relative that you wanted to tell about this experience—is there anything else you'd tell me?

8. The photovoice project was a new project for Dr. T's class this year. Can you **describe** the project briefly and **your reactions** to the project?

9. Do you **notice anything** about your environment that you did not notice before the HRE? If so, what?

10. Do you **notice anything** about your community that you did not notice before the HRE? If so, what?

11. This is the first year Dr. Tomasek has run a Herp BioBlitz. Can you **describe** the project briefly and your **reactions** to the project?

12. This is the second year Dr. Tomasek has run the Voucher Project, and the photo voucher part is new for this year. Can you **describe** the project briefly and your **reactions** to the project?

13. If someone asked you— "Why study reptiles and amphibians?" – **how would you answer**?

- Probe: Is there any other reason? (to exhaust their ideas; to see what connections they do make)
-

<u>IF THE INTERVIEW IS SHORTER THAN 35 MINUTES, ASK THE FOLLOWING QUESTION</u>:

14. Would you **recommend this HERP class to your Academy friends**?

- If YES… ask: "Ok, suppose I asked you to be an "ambassador" of the HERP Project. We always need youth to describe the summer experience to other high school youth so that we can recruit them to apply for the summer experience. What would you tell your friends to convince them that this was a good experience?"
- If NO… ask: "Ok, suppose your good friends came to you saying they wanted to do the HERP Project HRE. What would you tell your friend to convince them that this was not an experience worth doing?"
- For these experiences, depending on your familiarity with the participant, you may want to "role play" skeptical probes to get them to keep talking.

15. If you could **sign up for a second summer**, would you?

- If they say “no”, ask: Tell me all the reasons you wouldn’t sign up.
- If they say “yes”, ask: Why? What would you hope to get out of a second summer? Are there any activities that you would really want to do as a second-year participant?

16. Tell me about the **data collection activities** at the HRE.
    - Get them to describe first without any probes. If you need probes, ask:
        - What are some of the ways you collected data?
        - Why did you collect data, anyway? What was it for?
        - What did you learn from data collection?
        - What else do you want to tell me about the data collection?

APPENDIX F

FOCUS GROUP PROTOCOL

(Modified by Lacey Huffling and Terry Tomasek from Wang et al. (1998))

Have one student at a time share their photograph with the group.

Ask the following questions in order:

1.) What do you see here? The participant, who took the photograph being discussed, should ask this question of the other group members. The participants, who did not take the photograph being discussed, should answer this question.

2.) What is really happening here? The participant, who took the photograph being discussed, should share with the group what was happening in the photo, why they chose to take the photo, what was left out of the photo (why did they choose to frame the photo the way they did?), what was the purpose of taking the photo, who was the intended audience, and what was the call to action they were trying to elicit.

3.) How does this relate to you, your community, or herps? Every participant should be encouraged to share in this discussion.

4.) Why does this situation, condition, or strength exist? Every participant should be encouraged to share in this discussion.

5.) How can we use this image to educate others? Every participant should be encouraged to share in this discussion.

6.) What can we do about it? Every participant should be encouraged to share in this discussion.

APPENDIX G

HRE PRE/POST-TEST

(Designed and Modified by members of The HERP Project)

Name: ______________________________Student Research Assistant Yes No
Date: ____

HRE Location (please circle one): CCR Academy HRE Rockfish

Directions: Please provide as much detail as possible in your answers so that partial credit can be given.

1. Identify the calling animal in the sound clip that was played. (Please be as specific as possible, providing both a common name and a scientific name if you can.)

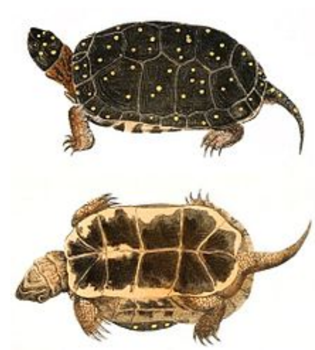
2. Name three reasons why these animals (that you just heard call) call.

3. What is herpetology?

4. Label (with scientific terms) the two indicated parts of a turtle.

Name of Top Shell =

Name of Bottom Shell =



5. List three differences between amphibians and reptiles.

6. Why do snakes flick their tongues?

7. What is a mark/recapture study and what can we determine from this type of investigation?

Use your classification key and your field guide to answer the next two questions:

8. What is the common name for this animal? ___________________________

9. What is the scientific name for this animal? ___________________________

10. Name the NC turtle that has a large head and a long, tapering tail with large scales on the top of the tail. _______________________________

11. Which measurement is most reasonable for a NC adult toad?
A. 0.5 grams b. 5.0 grams c. 50 grams d. 100 grams e. 500 grams

12. Your HRE is situated in which type of environment?
A. Eastern deciduous forest B. Tropical environment C. Pine flat woods D. Short grass prairie

13. A. Describe two ecological roles of snakes. Use complete sentences.
B. Describe two ways snakes are important to humans. Use complete sentences.

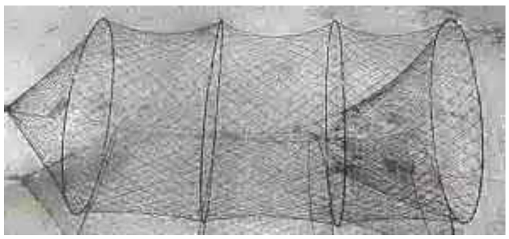
14. A. What type of animal is pictured? B. Identify the life cycle stage shown in each picture.

A.______________________________ A.____________________________

B.______________________________ B.____________________________

For questions 15-17, Give the name for each tool/equipment and describe its function.

15. Name: ___________________ Function: __________________________



16. Name: ___________________ Function: __________________________

17. Name: ___________________ Function: ___________________________

18. Which measurement is most reasonable for the length of the top shell of an adult Box Turtle?
A. 5 mm B. 50 mm C. 100 mm D. 500 mm

19. Which of the following aquatic environments in present-day NC were mostly created by humans?
A. Rivers B. Lakes C. Streams D. Temporary (ephemeral or vernal) pools

20. Describe three threats that reptiles face.
21. Name two habitat characteristics that allow for successful amphibian reproduction.

22. List and explain three threats that have contributed to declining amphibian populations.

<u>Required Questions for Rockfish/Optional Questions for CCR & Academy HRE</u>
23. How do male anoles attract mates?

24. Why is the invasion of brown anoles from Florida an environmental concern in NC?

APPENDIX H

HRE POST-SURVEY

(Designed and Modified by Heidi Carlone and members of The HERP Project)

Post-Survey of Science Attitudes, Interests, and Experiences

Your Name _______________________________________Rising Grade level: ___________

HERP Project Location (please circle one): CCR Academy HRE Rockfish

Section 1. Please indicate your level of agreement to the following statements about science in general, <u>thinking to before this week and now, after participating in the HRE</u>.

	Before participation in the HRE					**Now**				
	1 Not at all	**2**	**3**	**4**	**5 Very likely**	**1 Not at all**	**2**	**3**	**4**	**5 Very likely**
1. I think science is interesting.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
2. Science is important to me.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
3. I am good at science.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
4. I think I could be a good scientist.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
5. I think like a scientist.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
6. Scientists have a chance to make a difference in the world.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏

7. Science helps people.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
8. Scientists spend most of their time working alone.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
9. Scientists don’t have many other interests.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
10. There are lots of jobs available in science.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
11. Scientists’ work is not influenced by their own opinions.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
12. Scientists have to work hard.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
13. Science is a highly respected career.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
14. You have to be a genius to be a scientist.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
15. Scientists have to go to school for many years.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
16. Scientists do not have many friends.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
17. Scientists spend most of their time working indoors or in labs.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
18. There is not a lot of room for creativity in science.	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

Section 2. To what degree did participating in this herpetology research experience <u>increase</u> your:

	1 Not at all	**2**	**3**	**4**	**5 To a great degree**
19. Knowledge of science?	❑	❑	❑	❑	❑
20. Confidence in doing science?	❑	❑	❑	❑	❑
21. Interest in science?	❑	❑	❑	❑	❑
22. Interest in nature	❑	❑	❑	❑	❑
23. Ability to use scientific tools?	❑	❑	❑	❑	❑
24. Interest in participating in other	❑	❑	❑	❑	❑

science experiences?					
25. Understanding of threats that reptiles and amphibians face?	❑	❑	❑	❑	❑
26. Connection to nature	❑	❑	❑	❑	❑
27. Empathy for animals?	❑	❑	❑	❑	❑
28. Awareness of careers in science or related fields?	❑	❑	❑	❑	❑
29. Connections to people in science or related fields?	❑	❑	❑	❑	❑
30. Understanding of what people do in science-related jobs or careers?	❑	❑	❑	❑	❑
31. Desire to find a science-related job/career?	❑	❑	❑	❑	❑

Section 3. To what degree did participating in this herpetology research experience make you feel:

	1 Not at all	2	3	4	5 To a great degree
32. Confident to try new things?	❑	❑	❑	❑	❑
33. Like a science person?	❑	❑	❑	❑	❑
34. More aware of your strengths and weaknesses?	❑	❑	❑	❑	❑
35. Brave?	❑	❑	❑	❑	❑
36. Interested in taking care of the environment?	❑	❑	❑	❑	❑
37. That you have a good future ahead of you?	❑	❑	❑	❑	❑
38. That you could be good at science or a related field?	❑	❑	❑	❑	❑
39. Connected to living things in my local environment?	❑	❑	❑	❑	❑
40. Curious about nature?	❑	❑	❑	❑	❑
41. Successful?	❑	❑	❑	❑	❑

4. To what degree did participating in this herpetology research experience make you feel like it is possible for you to:

	1 Not at all	2	3	4	5 To a great degree
42. Think like a scientist?	❑	❑	❑	❑	❑
43. Talk like a scientist?	❑	❑	❑	❑	❑

44. Teach others about reptiles and amphibians?	❏	❏	❏	❏	❏
45. Be seen as smart in science?	❏	❏	❏	❏	❏
46. Help your friends get good grades in science next year?	❏	❏	❏	❏	❏
47. Use what you know about science outside of school?	❏	❏	❏	❏	❏
48. Study science in college?	❏	❏	❏	❏	❏
49. Contribute to science?	❏	❏	❏	❏	❏
50. Think about joining a science-related club or group?	❏	❏	❏	❏	❏
51. Start a science hobby?	❏	❏	❏	❏	❏

Section 5. Please indicate on a scale of 1 (I learned very little) to 5 (I learned very much) how much you learned by participating in the following activities.

	1 I learned nothing at all	2	3	4	5 I learned very much
52. Box Turtles with Dogs	❏	❏	❏	❏	❏
53. Ephemeral (vernal or temporary) Pools - CCR	❏	❏	❏	❏	❏
54. Snakes Project	❏	❏	❏	❏	❏
55. Aquatic Turtles	❏	❏	❏	❏	❏
56. Stream Salamanders	❏	❏	❏	❏	❏
57. Night Hike (first night)	❏	❏	❏	❏	❏
58. CASP	❏	❏	❏	❏	❏
59. Frogs of the Piedmont (Mr. J Hall)	❏	❏	❏	❏	❏
60. CCR - Tree Pythons	❏	❏	❏	❏	❏
61. Rockfish - Herp Photography	❏	❏	❏	❏	❏
62. Rockfish - Lizards Project	❏	❏	❏	❏	❏

Section 6. Please indicate on a scale of 1 (Very uninteresting) to 5 (Very interesting) how interesting you found participating in the following activities.

	1 Very uninteresting	2	3	4	5 Very interesting
63. Box Turtles with Dogs	❏	❏	❏	❏	❏
64. Ephemeral (vernal or temporary) Pools - CCR	❏	❏	❏	❏	❏
65. Snakes Project	❏	❏	❏	❏	❏

66. Aquatic Turtles	❑	❑	❑	❑	❑
67. Stream Salamanders	❑	❑	❑	❑	❑
68. Night Hike, First Night	❑	❑	❑	❑	❑
69. CASP	❑	❑	❑	❑	❑
70. Frogs of the Piedmont (Mr. J Hall)	❑	❑	❑	❑	❑
71. CCR - Tree Pythons	❑	❑	❑	❑	❑
72. Rockfish - Herp Photography	❑	❑	❑	❑	❑
73. Rockfish - Lizards Project	❑	❑	❑	❑	❑

74. For any activities you rated as a 1 or 2 (relatively uninteresting), please provide an explanation for that rating:

____

____

75. Please tell us about your experience filling in data using the iPads and Android devices.

____

____

Section 9. Please rate your <u>enjoyment</u> on a scale of 1 (low) to 5 (high) regarding the HERP Activity Electives in which you participated.

	I did not participate	1 Low Enjoyment	2	3	4	5 High Enjoyment
76. Herp Dissection	❑	❑	❑	❑	❑	❑
77. Snake Skinning	❑	❑	❑	❑	❑	❑
78. Nature jewelry	❑	❑	❑	❑	❑	❑
79. Evening Ephemeral Pool Field Trip –only at CCR	❑	❑	❑	❑	❑	❑
80. Drawing & Making Models	❑	❑	❑	❑	❑	❑
81. Lizard Lassoing – only at CCR	❑	❑	❑	❑	❑	❑
82. Costume & Mask Making	❑	❑	❑	❑	❑	❑
83. Council of All Beings	❑	❑	❑	❑	❑	❑
84. Photo Journalist Project	❑	❑	❑	❑	❑	❑
85. Student Documentaries	❑	❑	❑	❑	❑	❑

86. Please rate on a scale of 1 (Poor) to 5 (Excellent) the HERPS instructors':

	1 Poor	2	3	4	5 Excellent
87. Ability to help you understand information presented	❑	❑	❑	❑	❑
88. Ability to make what you learned interesting	❑	❑	❑	❑	❑
89. Ability to make learning activities enjoyable	❑	❑	❑	❑	❑
90. Ability to answer your questions	❑	❑	❑	❑	❑

91. What did you like best about this herpetology research experience and why?

____

____

____

____

92. What would you change about this herpetology research experience and why?

____

____

____

____

93. If there is anything else that you would like to add, please do so here.

____

____

____

Thank you for completing this survey!

APPENDIX I

VALIDITY MATRIX

(Created by Lacey Huffling)

Research questions	Data collection methods	Data analysis methods
How were youths' experiences leveraged as their CEA developed during the field ecology program?	Field notes Focus groups Individual interviews Photovoice assignments	Theme coding of field notes, focus groups, interviews, and student assignments
How was critical environmental agency enabled during the field ecology program?	Field notes Focus groups Individual interviews Pre/post-tests Pre/post-surveys Photovoice assignments	Theme coding of field notes, focus groups, interviews, and student assignments, Comparison of pre/post tests and surveys
How was critical environmental agency constrained during the field ecology program?	Field notes Focus groups Individual interviews Photovoice assignments	Theme coding of field notes, focus groups, interviews, and student assignments,